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LITANI RIVER BASIN MANAGEMENT SUPPORT PROGRAM

PROJECT COMPLETION REPORT (OCTOBER 2009-APRIL 2014)

April 2014
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ACRONYMS

AFD	Agence Française de Development (French Aid)
AUB	American University of Beirut (LRBMS subcontractor)
CO	Contracting Officer
COR	Contracting Officer's Representative
COP	Chief of Party
CDR	Center for Development and Reconstruction
CNRS	Centre National de Recherches Scientifiques (National Council for Scientific Research)
DAHNT	Dar Al Handasah Nazeh Taleb (LRBMS subcontractor)
EDL	Electricite du Liban
GIS	Geographic Information System
GOL	Government of Lebanon
GW	GroundWater
IQC	Indefinite Quantity Contract (contracting mechanism for USAID)
IRBM	Integrated River Basin Management
IWRM	Integrated Water Resources Management
IRG	International Resources Group (US consulting firm, prime LRBMS contractor)
LRA	Litani River Authority (also “Office National du Litani”, counterpart agency for LRBMS)
LRB	Litani River Basin
LRBMS	Litani River Basin Management Support (USAID-funded Program
ONL	Office National du Litani (also called Litani River Authority)
M&E	Monitoring & Evaluation
MCM	Million of cubic meters (also Mm3)
MEW	Ministry of Energy and Water
NGO	Non Governmental Organization
O&M	Operation & Maintenance
PMP	Performance Monitoring Plan
TA	Technical Assistance
USAID	United States Agency for International Development
WUA	Water User Association

EXECUTIVE SUMMARY

CONTEXT

Water management is weak in Lebanon as in other Middle-Eastern countries, due to:

- A political focus on engineering projects and construction as tangible/visible outcomes, while management reforms are avoided, even if much cheaper and often more efficient;
- A lack of leadership and political will to reform, take difficult decisions, enforce regulations;
- A shortage of qualified staff and technical/managerial capacity in governmental agencies; and
- The usual top-down management which centralizes decision power and stifles initiative.

Within that context, the Litani River is the largest river in Lebanon, draining the central and south Bekaa. Its river basin suffers from widespread water pollution (residential, industrial, agricultural, garbage), and is a threat to public health as pollution propagates to soils, crops, and animals, as well as an obstacle to the socio-economic development and well-being of local communities. It is also becoming a growing source of conflicts due to competing demands from farmers, industries, and residents, while waters from the Litani River are diverted to provide electricity for Lebanon, irrigation and domestic water for the South (Canal 800), and also Beirut (canal Awali-Beirut). Groundwater levels decline and serious water shortages already occur in the Litani River Basin (LRB).

THE INTEGRATED WATER RESOURCES MANAGEMENT APPROACH

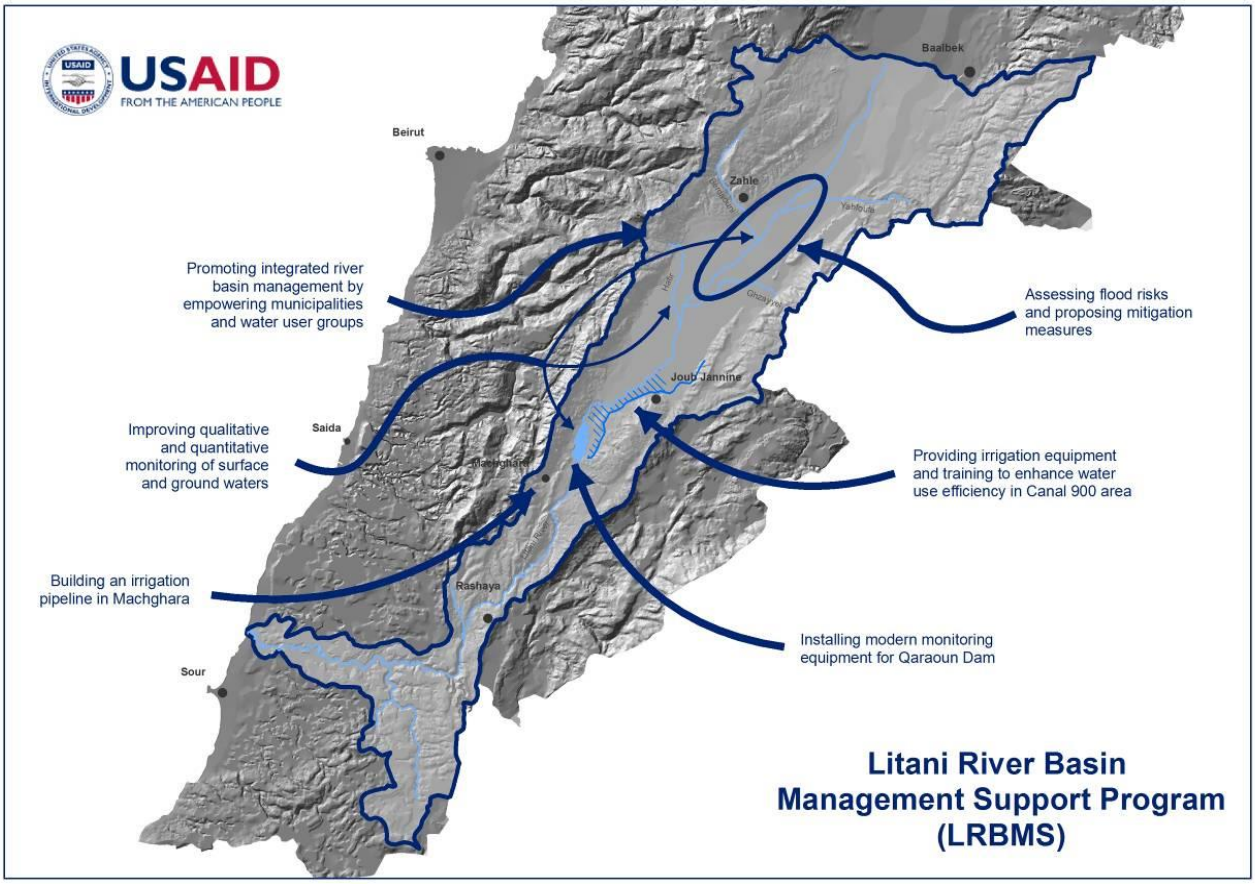
Solutions do exist to reverse negative water trends and establish sustainable management practices so that all water users can equitably access and benefit from water resources. The Integrated Water Resources Management (IWRM) approach is based on principles of social equity, economic efficiency, and environmental sustainability. Concretely, Integrated River Basin Management (IRBM) focuses on one river basin as a coherent and decentralized unit, and involves four types of activities:

- **Infrastructure development,** needed but far from sufficient;
- **Monitoring and enforcement** to control withdrawals and releases, and protect water resources from illegal uses and abuses such as untreated releases and groundwater over-extraction;
- **Improved water governance** (i.e. laws, institutional roles, policies) to clarify roles, improve coordination and accountability and thus the overall performance of water agencies;
- Finally and essentially, **water users' awareness and participation** to achieve lasting changes in the behaviors of water users. **Water users are the issue since they pollute and waste water. How can one hope to solve the water issue without involving them?**

PROGRAM BACKGROUND

The Litani River Basin Management Support (LRMBS) Program was a four and a half-year program to improve water management in the Litani River Basin. It was implemented by International Resources Group (IRG), in cooperation with the Litani River Authority (LRA), and was funded by USAID. The program began in October 2009 and had four components: building capacity towards Integrated River Basin Management (IRBM), enhancing water monitoring, improving irrigation management, and developing pro-active risk management. The LRA, governmental agency operating the Qaraoun Dam, hydropower plats and irrigation systems, was chosen as counterpart and focus for this project since it:

- Is a known and autonomous public agency with a fitting geographical mandate (the LRB);
- Has field presence and existing relationships with water users and Municipalities;
- Is self-financed and administratively autonomous (in principle if not in practice); and
- Already performs water monitoring functions and has thus knowledge of the water situation.



COMPONENT 1: CAPACITY-BUILDING TOWARDS IRBM

The goals of this component were to:

- Improve the water governance framework to promote IRBM and ensure the success and sustainability of LRBMS technical activities (under all four components);
- Build the capacity of LRA to handle water management beyond O&M of infrastructure; and
- Empower Municipalities and other non-governmental entities representing water users so as to facilitate water conflicts, address local water issues, and change water use behaviors.

LRBMS first proposed to the LRA Board a one-page vision statement to endorse IRBM. This was followed by a report exploring the future water management role of the LRA, and a revised legal mandate for LRA to handle water management functions in the LRB.

LRBMS prepared a baseline River Basin Assessment (water management, water quantity, and water quality issues) which was endorsed by LRB Municipalities. A study tour was organized to France for LRB Mayors and LRA staff to experience participatory decentralized water management. Upon return to Lebanon, LRB Mayors obtained support from H.E. Nabih Berri, Parliament Speaker, and the drafting of a Programming Law to address water pollution in the LRB (Law now under review by the Parliament).

LRBMS then prepared a focused River Basin Management Plan, a 5-year action plan with an integrated set of 36 actions covering infrastructure development, monitoring, enforcement, and awareness raising to address quality, quantity and governance issues. LRBMS also assisted the formation of a water federation of LRB Municipalities to pool resources, coordinate their actions, jointly implement water activities, and advocate to central authorities. During a second study tour to France, this federation signed a partnership with RES' Eau 34, a French network of river basin committees.

LRBMS also upgraded the data/communication networks of LRA, providing new servers and software for communication, file sharing and backups, and implemented an integrated financial/accounting system to consolidate financial transactions, simplify data entry, reduce errors, and improve reporting.

LRBMS carried out awareness activities targeting all types of water users, using billboards, posters and brochures, to increase their understanding of water pollutions and wastages. A one-hour puppet show was delivered to 3,000 school students, and a 20-min documentary was prepared to present LRBMS' approach and achievements. LRBMS also supported community activities such as river clean-ups in the LRB, involving residents to turn them into informed and responsible water users.

Finally, LRBMS built a 3-hectare pilot wetland to clean waters from the Litani River, as a low maintenance alternative to wastewater treatment plants.

Study Tour to France: meeting with River Basin Committee (Mayors)

		Infrastructure	Monitoring / Enforcement	Awareness / Participation
Governance				
QuaLity	URban sewage			
	Industrial sewage			
	Solid Waste			
	Agriculture			
QuanTity				

COMPONENT 2: LONG-TERM WATER MONITORING

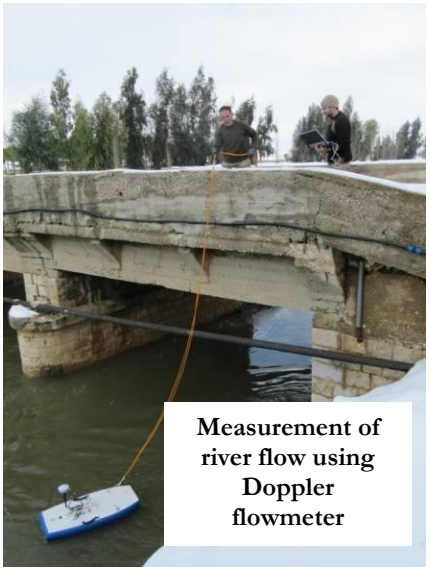
Sound management rests on reliable information. The objective of this component was to improve the collection, quality control, storage, and dissemination of water data in the Litani River Basin, in terms of both quality and quantity, covering both surface and groundwater.

LRBMS provided water monitoring equipment (quality and flow meters), and installed five automated gauging stations for quality and quantity monitoring of the Litani River and tributaries. LRBMS also upgraded the HYDATA database used for storing water quantity data for Lebanese gauging stations.

LRBMS initiated groundwater monitoring in the LRB by installing fourteen automated observation wells to routinely collect qualitative and quantitative data. A MODFLOW groundwater computer model was also built to understand the groundwater situation, forecast future levels, and test management strategies.

LRBMS provided all corresponding capacity building for LRA staff to operate and maintain water monitoring equipment, and compiled all existing Geographic Information Systems into one LRA system. A water information bulletin (water quality index aggregating several water quality indicators) was also designed for LRA to disseminate results to Bekaa Municipalities and residents on a monthly basis.

Installation of sensor in new gauging station



Measurement of river flow using Doppler flowmeter

COMPONENT 3: PARTICIPATORY IRRIGATION MANAGEMENT

Irrigation uses a large share of water resources in Lebanon and heavily draws from groundwater. The sustainability of irrigation in the LRB is uncertain due to groundwater depletion, inefficient use of water, and over-use of fertilizers and pesticides. The objective of this component was to improve irrigation practices and specifically increase water use efficiency.

LRBMS focused on the pilot Canal 900, the only modern (pressurized) irrigation system in Lebanon. Supplied from Qaraoun Lake, the system is managed by LRA and meant to serve 2000 hectares.

LRBMS reviewed operational and maintenance activities for Canal 900 and suggested improvements through the development of an O&M plan. Serious structural issues (due to weak design and construction) were also identified and led LRBMS to procure and install O&M equipment (valves, airvents, flow-meters) and build two gravity diversions to increase the served area. LRBMS also provided all corresponding capacity building for LRA staff to operate and maintain this equipment. A computer model of the network (EPANET software) was developed and used to optimize water delivery.
In parallel, LRBMS engaged farmers to raise awareness on water pollution and water use efficiency issues. An exhaustive training program was developed and implemented with the following themes:

- On-farm water management and irrigation scheduling;
- Soil management, rational use of fertilizers and pesticides; and
- Modern irrigation and crop production.

A specific demonstration program was implemented to promote the use of drip/micro-sprinkler irrigation equipment to increase water use efficiency and improve incomes through decreased labor and increased yields. LRBMS also supported the revival of soil and water analyses at the LRA Kherbet Hanafar agricultural extension center.

Finally LRBMS facilitated better communications between LRA and farmers, and the formation of a Canal 900 Farmers Committee to that end.

COMPONENT 4: RISK MANAGEMENT

The objectives of this component were to:

- Assess risks associated with dam failure and flooding issues in the Litani River Basin;
- Establish monitoring tools that provide advance indications of potential emergency events; and
- Develop procedures that can mitigate the impacts of such events.

The need for monitoring of Qaraoun Dam is critical due to its proximity to the Yammouneh fault. In parallel, flooding from the Litani River can affect a large area of the Bekaa valley (upstream of the dam).

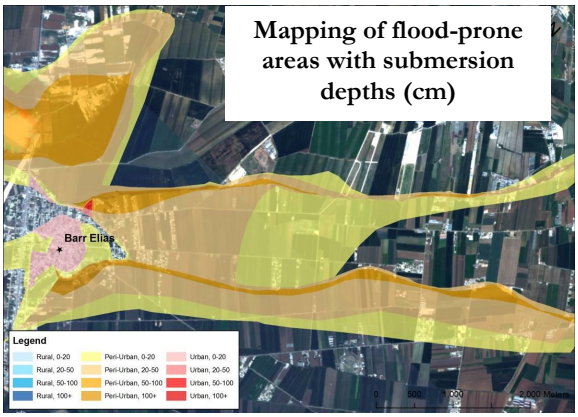
A Failure Mode Analysis was prepared to characterize the types of failure for Qaraoun Dam and accordingly define safety monitoring needs. Said equipment was procured and installed and a Dam Safety Monitoring Plan was prepared for LRA staff to implement. LRA staff were sent to a 2-week dam safety monitoring training at the US Bureau of Reclamation. LRBMS conducted two underwater inspections of the dam upstream facing to detect leaks and assisted their successful repair. To facilitate future similar inspections, LRBMS purchased a dedicated remotely operated vehicle and trained LRA staff to use it.

Use of Rover for underwater inspections of Qaraoun Dam

Moreover LRBMS conducted a specific seismic sensitivity analysis of Qaraoun Dam which confirmed that the rockfill dam should probably withstand even extreme earthquakes with minimal damage. LRBMS procured and installed overspeed sensors to protect the turbines in case of gallery failure.

LRBMS also conducted a bathymetric survey of the reservoir to assess the amount of sedimentation since construction of the dam (which so far remains modest). Finally LRBMS assessed the potential impact of a hypothetical (but very unlikely) failure of Qaraoun Dam and drafted an Emergency Management Plan to prepare Lebanese Authorities to such an event.

Regarding flood management in the LRB, LRBMS conducted a flood field survey on the large February 2003 flood. A computer river flow model was then built (under HEC-RAS), calibrated, and used to predict the extent and magnitude of different flood levels and test various flood management approaches and works.



A flood management plan was accordingly prepared to assist LRA and Municipalities to plan for future events, emphasizing the need for regulating human activities (e.g. dumping of solid waste), and for implementing natural solutions (flood expansion areas) and nonstructural approaches (smart urban planning) instead of expensive structural solutions (embankments and dams).

SUSTAINABILITY

The sustainability of LRBMS technical activities will rely, in the absence of internal or external accountability, on the good will of LRA managers and staff which cannot be predicted.

The sustainability of LRBMS activities on Canal 900 dams is fairly good since both structural and managerial improvements were designed, planned, and implemented with LRA staff who are under some pressure from farmers to perform and deliver results. The direct communication between LRA and farmers should also continue as both sides saw direct benefits from the interaction.

The sustainability of LRBMS activities on dam safety monitoring is good since Qaraoun Dam is the "raison d'être" of LRA and its single source of revenues (through electricity sale to the national grid).

The dissemination of IWRM/IRBM principles will hopefully continue, especially if international donors make it a pre-requisite to their funding and technical assistance programs (as French Aid-AFD currently does when demanding the promulgation of the Water Code). **Now institutional change and policy reform take time, and two project cycles (4-5 years each) are a minimum to achieve lasting progress.**

FOLLOW-UP THEMES

A follow-up to LRBMS should thus be considered by USAID, given buy-in from Ministry of Energy and Water (MEW), LRA, Municipalities, and/or civil society/private sector entities in Lebanon. The four LRBMS components would remain valid for such a follow-up, with critical themes being:

- Awareness raising to change water use practices, along with enforcement of water regulations;
- Participation, both in terms of involving water users in water activities, and empowering local leaders (farmer or business representatives, Mayors, etc.) to tackle local water issues;
- IRBM as a proven approach to significantly improve the effectiveness and efficiency of water management;
- Water monitoring, chiefly in terms of disseminating data (to ensure its reliability, and to support the promotion of good water use practices and prevention of harmful behaviors), flow measurement, and groundwater management (as hidden part of the water cycle);
- Agricultural Extension Services, as essential to change practices of farmers in terms of water use efficiency and soil management;
- Participatory Irrigation Management to transfer some O&M responsibilities to farmers
- Risk management, since pro-active planning is much cheaper than crisis management.

CONCLUSION

Most assessments of the water sector in Lebanon, and notably the World Bank's 2012 Country Water Sector Assistance Strategy, identify four main issues preventing progress. Solutions to these four governance issues were specifically proposed by LRBMS:

Issue	Solution proposed by LRBMS
Weak performance and unclear roles/responsibilities in the water sector	Empowerment of LRA and delegation of water management functions (for example in terms of awareness and enforcement of water withdrawals/releases)
Lack of focus (no prioritization) and unrealistic planning (much beyond possible funding)	Drafting of a focused and realistic 5-y River Basin Management Plan
Lack of coordination and capacity among water agencies	Implementation of this Plan under supervision of coordinating Litani River Basin Committee involving both water agencies and Municipalities
Lack of water user participation	Mobilizing water users through awareness raising and collaborative activities (river cleanups) to generate stewardship and promote better water use practices

1. INTRODUCTION

1.1. AUTHORIZATION

International Resources Group (IRG) was contracted by USAID/Lebanon (Contract EPP-I-00-04-00024-00 Task Order No. 7) under the Integrated Water and Coastal Resources Management Indefinite Quantity Contract (IQC) II to implement the Litani River Basin Management Support (LRBMS) Program. The initial period for performance of the contract was September 29, 2009 to September 30, 2012, and was extended thrice until April 30, 2014.

1.2. PROGRAM OBJECTIVES

The LRBMS program is part of USAID's increasing support for the water sector in Lebanon. The purpose of the LRBMS Program is to set the ground for improved, more efficient and sustainable basin management in the Litani River Basin (LRB) through provision of technical support to the Litani River Authority (LRA) and implementation of limited small scale infrastructure activities.

To achieve the program objectives, LRBMS undertook activities grouped under the following four components:

1) Building Capacity of LRA towards Integrated River Basin Management (IRBM)

2) Long Term Water Monitoring of the Litani River

3) Integrated Irrigation Management with two sub-components:
   a. Participatory Agriculture Extension, implemented on a Pilot Area, the West Bekaa Irrigation Management Project
   b. Machghara Plain Irrigation

4) Risk Management with two sub-components:
   a. Qaraoun Dam Safety Monitoring System
   b. Litani River Flood Management

1.3. PURPOSE AND CONTENTS OF THE REPORT

This report presents the results, achievements, and experiences from the implementation of the LRBMS program. It includes the following chapters:

- Chapter 2 explains the background and rationale for the LRBMS program;
- Chapters 3 presents the Integrated Water Resources Management (IWRM) or Integrated River Basin Management (IRBM) approach at the core of LRBMS;

- Chapters 4 to 7: for each component, results are presented against the scope of work; technical reports and capacity-building activities are listed, while problems encountered and lessons learned are detailed, as well as sustainability considerations and potential follow-up themes;
- Chapter 8 lists all the administrative deliverables produced and also provides a performance monitoring (M&E) summary;
- Chapter 9 provides a financial and staffing overview of LRBMS;
- Chapter 10 presents an account of LRBMS training and procurement activities;
- Chapter 11 describes cross-sectoral activities under LRBMS (communication, gender, environmental management, and climate change); and finally
- Chapter 12 points to some references for background and additional information on water management in Lebanon and in the LRB.

2. BACKGROUND

2.1. OVERALL SITUATION

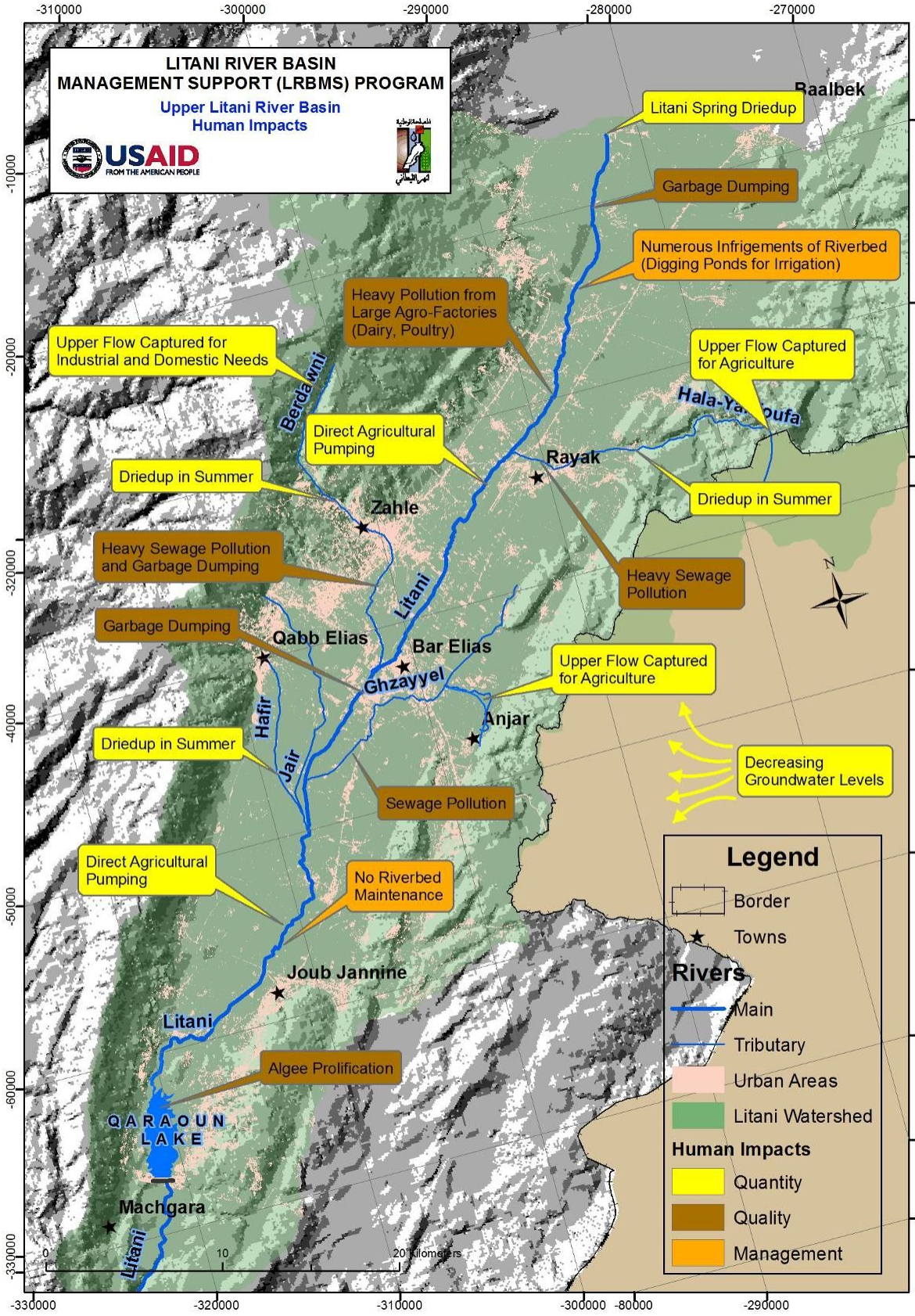
The Litani River is the largest river in Lebanon and drains the central and south Bekaa Valley. Its water resources have been harnessed for human uses since the 1960s through the construction of Qaraoun Dam (see map next page).

The Litani River Basin today faces increasing water demands, groundwater over-exploitation, and extensive pollution. In summer, the Litani River shows a meager flow, much decreased from 40 years ago. The river's smell reveals its origin and contents: raw sewage, untreated industrial effluents and agricultural runoff. A walk along the river shows:

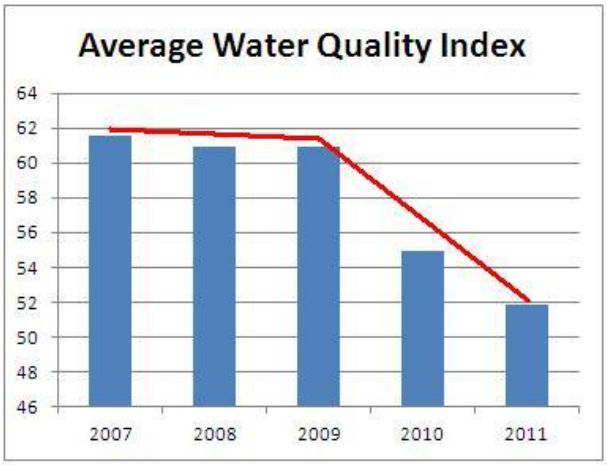
- Extensive garbage dumping;
- Direct release of urban wastewater;
- Uncontrolled industrial discharges;
- Lack of riverbed maintenance, infringements and unauthorized diversions.

These activities are often illegal but there are few alternatives for water users to behave differently.

The river is now a threat to public health as water pollution propagates to soils, crops, and animals, as well as an obstacle to the socio-economic development and well-being of riparian communities. It is also becoming a growing source of conflicts due to competing demands from farmers, industries, and residents. Moreover, the Litani River is asked to provide electricity for Lebanon, irrigation and domestic water for the South (and soon also Beirut), while serious water shortages already exist for urban centers and irrigation in the Bekaa, with groundwater levels going down due to over-abstraction.


LITANI RIVER BASIN
MANAGEMENT SUPPORT (LRBMS) PROGRAM
Upper Litani River Basin
Human Impacts
USAID
FROM THE AMERICAN PEOPLE
Baalbek
Litani Spring Driedup
Garbage Dumping
Numerous Infrigements of Riverbed (Digging Ponds for Irrigation)
Heavy Pollution from Large Agro-Factories (Dairy, Poultry)
Upper Flow Captured for Industrial and Domestic Needs
Upper Flow Captured for Agriculture
Berdawni
Hala-Ya oufa
Direct Agricultural Pumping
Rayak
Driedup in Summer
Driedup in Summer
Zahle
Heavy Sewage Pollution and Garbage Dumping
Heavy Sewage Pollution
Litani
Garbage Dumping
Qabb Elias
Bar Elias
Ghzayyel
Upper Flow Captured for Agriculture
Hafir
Anjar
Jair
Driedup in Summer
Decreasing Groundwater Levels
Sewage Pollution
Direct Agricultural Pumping
No Riverbed Maintenance
Joub Jannine
Litani
Algee Prolification
QARAOUN LAKE
Machgara
Litani
0
10
20 Kilometers
Legend
Border
Towns
Rivers
Main
Tributary
Urban Areas
Litani Watershed
Human Impacts
Quantity
Quality
Management

2.2. WATER QUALITY ISSUE



Water quality critically impacts and limits water use: polluted waters may be unfit for drinking, industrial, or irrigation uses, and only usable after costly treatment.

The quality of surface waters in the Litani River Basin varies seasonally and spatially, but is generally bad to very bad (water quality index aggregates several indicators):

- The highest levels of contamination are in the mid-upper basin (between Rayak and Bar Elias) where there is a larger concentration of both residents and industries;
- Many summer water samples exceed drinking, bathing, domestic, and irrigation water quality standards;
- Untreated wastewater discharges, both domestic and industrial, are one of the primary sources of pollution, as confirmed by high biological oxygen demand and high levels of coliforms;
- Agriculture over-fertilization is an important source of pollution, as demonstrated by elevated levels of phosphates and nitrates (both are key constituents of fertilizers); and
- Some metal buildup is now observed in the upper Litani River Basin, with presence of cadmium and manganese sometimes above safe drinking water limits.

All these types of pollution are threats to public health, either directly, from drinking or being in contact with water, or indirectly: poor quality irrigation water contaminates crops and then human beings, leading to long-term deficiencies and diseases. The quality of groundwater also shows signs of pollution, which is worrisome since groundwater is the main source of domestic water for residents, businesses and industries.

Water diseases in the Bekaa

Poor water quality is a serious public health issue. Water-borne diseases are worldwide one of the leading causes of mortality. The occurrence of dysentery, typhoid fever and hepatitis A in the Bekaa is 7.5 annual cases per 10,000, that is twice the national average (2009 statistics from Ministry of Public Health). These are reported cases only, actual cases could be 5-10 times higher.

2.3. WATER QUANTITY ISSUE

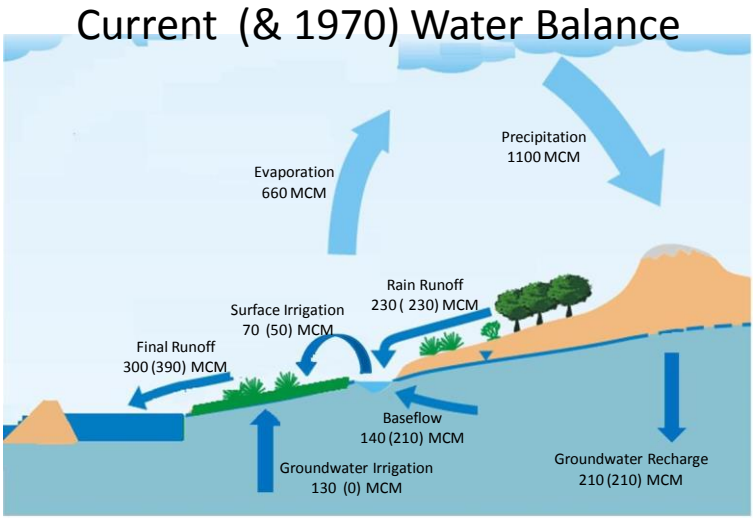
Water resources of the upper Litani River Basin are provided by winter rains and mostly used in summer for irrigation, with a smaller share being used for domestic and industrial needs. Unused winter rains are stored in Lake Qaraoun where they are currently diverted year-round to the Awali River for hydropower production.

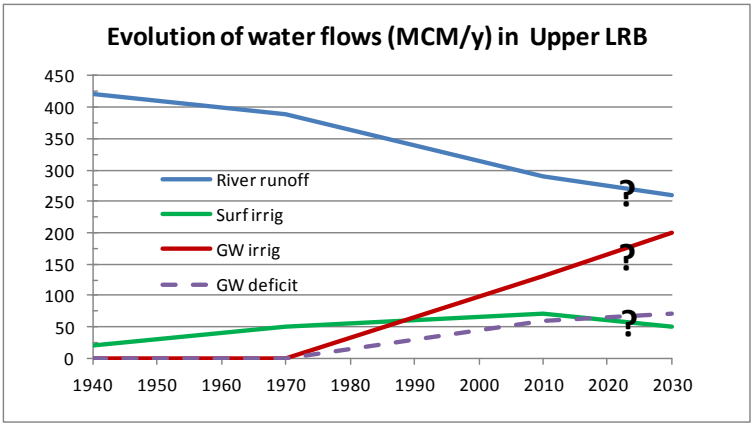
Water volumes and human needs

A human being consumes on average at least 1,000 m^3 per year, out of which 900 m^3 are needed for food production, the rest being for domestic and industrial needs. One million m3 (Mm3 or MCM) per year can thus provide for about 1,000 people.

A water balance of the upper Litani River Basin shows that human pressure on water resources has increased drastically since the 1970s, as confirmed by:

- Significant decrease in river flows, due to increased water withdrawals, through tapping of springs and direct pumping or diversion from the river, chiefly for irrigation purposes; and
- Substantial groundwater depletion, due to extensive pumping both for domestic and irrigation needs.





These are evident indicators of unsustainable water allocation practices in the Litani River Basin. As population and water demands keep increasing, the question of fairly allocating decreasing water volumes is an increasingly difficult decision which calls for transparent discussions and planning, especially since the Litani waters are asked to provide other regions of Lebanon including Beirut and the South.

2.4. WATER MANAGEMENT ISSUE

Water management in Lebanon is similar to other Middle-Eastern countries. Reforms and improvements are often hampered by:

- A political focus on engineering projects and construction as being tangible/visible outcomes, avoiding management reforms, perceived as more difficult, even if much cheaper and often more efficient;
- A lack of leadership and political will to:
    - Follow through and enforce reforms (notably those impacting governmental staff);
    - Address critical issues and take difficult decisions (e.g. water tariffs), especially if these challenge special interests or risk unpopularity;
    - Ensure solid reliable water monitoring, raise water user awareness and enforce water regulations (notably regarding withdrawals and releases);
- An overall lack of qualified staff and capacity in governmental agencies, both at technical and managerial levels;
- The usual top-down management which centralizes decision power and stifles initiative;

Much remains to be done to improve water management in Lebanon generally and in the Litani River Basin specifically. The main requisite is to follow the universal principles of transparency, participation and accountability, which are sorely lacking:

- Data remains a source of power for most government officials and is often hidden, toyed with, or ignored, while decisions are taken at central level in an opaque manner;
- Participation by water users, residents and other stakeholders is token at best, with decisions and plans being presented when final; Municipalities, which can be the direct link with residents and the main vehicle for democracy, are rarely involved in planning and decision processes; and
- Accountability and performance monitoring are lacking in the public sector, governmental agencies, departments and staff do not have clear responsibilities, nor annual objectives or targets.

3. OVERALL VISION

3.1. WHAT IS IWRM-IRBM?

The time is over when water management was a simple issue of water development, that is locating and mobilizing/harnessing water resources through engineering works to supply users. Today multiple and growing water needs often outstrip availabilities and most water issues involve pollutions and wastages due to inadequate water practices and weak management. In this view, infrastructure development is not sufficient. Water management is now a political process that cannot be solely handled by water managers and engineers.

Solutions do exist to reverse negative water trends and establish sustainable management practices so that all water users can equitably access and benefit from water resources. The Integrated Water Resources Management (IWRM) approach is based on the three principles of social equity, economic efficiency and environmental sustainability.

Integrated Water Resources Management (IWRM)

It has been defined by the Global Water Partnership (GWP) as "a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems."

Concretely, Integrated River Basin Management (IRBM) focuses on one river basin as a hydrological coherent and administratively decentralized unit, and applies IWRM through four types of activities:

- **Infrastructure development** (construction of dams, networks, treatment plants, etc.), much needed, but alone not sufficient as it cannot address challenges such as agricultural pollution and allocation conflicts;
- **Monitoring and enforcement** to control withdrawals and releases, and protect water resources from illegal uses and abuses such as untreated releases and groundwater over-extraction;
- **Improved water governance** (i.e. laws, institutional roles, policies) to clarify and delegate roles, improve coordination and accountability and thus the overall performance of relevant governmental entities;
- Finally and essentially, **water users' awareness and participation** to achieve lasting changes in the behaviors of water users once they better understand the consequences of their actions and feel responsible and adapt their water use practices. Water users are the issue since they pollute and waste water. How can one hope to solve the water issue without involving them?

3.2. WHY IRBM FOR THE LITANI RIVER BASIN?

The Litani River is the largest river of Lebanon, one of the few perennial ones, and flows entirely within the national territory. Its river basin is the central and south Bekaa, a peripheral and somewhat neglected region of Lebanon but also its main granary. The current water situation (see previous chapter 2) represents not only a serious public health issue, but also a clear obstacle for socio-economic development for a population of 400,000 people.

As mentioned earlier (section 2.4), the water quality and quantity issues of the Litani River Basin are compounded by serious water governance issues in Lebanon whereby responsibilities for water management (notably monitoring and enforcement, but also monitoring, infrastructure development, awareness raising, etc.) are spread over several governmental agencies with little coordination, weak implementation and follow-up/operation of water structures. In the words of the World Bank[1], "the current regulatory instruments are inadequate to promote the sustainable management of water resources. Laws and regulations governing water resource management are not up-to-date." Similarly the recent National Water Sector Strategy (NWSS) prepared by the Ministry of Energy and Water, faces key constraints in terms of weak accountability, reform and operational capacity needs, and stakeholder participation[2].

IRBM is the perfect framework to address these issues in an effective manner, providing short- and long-term solutions by looking beyond infrastructure development, combining different types of activities, and involving water users. In parallel, a unique opportunity for better water management is presented by the Litani River Authority (LRA, also known as Office National du Litani), a governmental agency established in 1954 to harness water resources of the Litani River for the development of the central and southern Lebanon. For the past 50 years, it has operated the Qaraoun reservoir, produced electricity from three hydroelectric power plants and managed several irrigation systems. Even if the LRA does not yet have a water management mandate, it:

- Is a well established and semi-autonomous public agency with the appropriate geographical mandate;
- Has field presence in terms of technical staff, infrastructure, equipment, and existing relationships with many water users, including farmers, municipalities and industries;
- Is self-financed and administratively autonomous (in principle if not in practice); and

[1] World Bank, 2010: Republic of Lebanon - Water Sector: Public Expenditure Review

[2] World Bank, 2012: Republic of Lebanon - Country Water Sector Assistance Strategy

- Already performs essential water monitoring functions and has a unique knowledge of the water situation in the basin.

3.3. EXPECTED OUTCOMES

The overall objective of LRBMS was to improve water management in the Litani River Basin, and to this end, to pave the way for LRA to transition towards an IRBM role. LRBMS and LRA agreed that the **four essential tools for a planned, participative, coherent and effective approach to solving water issues in the Litani River Basin** are:

- **Establishment of a River Basin Committee** to bring together central agencies, local authorities, and representatives from residents and water users;
- **Preparation, implementation and monitoring of a River Basin Management Plan;**
- **Establishment and empowerment of a River Basin Agency;** and
- **Definition and implementation of priority and short-term activities** to raise public awareness, involve Municipalities and local actors, demonstrate quick results, and ensure credibility.

The **adoption throughout of participatory processes** was also promoted, in order to:

- Involve residents and water users, through their representatives, as key actors solving water issues by adapting their practices (in terms of water use efficiency and pollution control);
- Bring together central agencies, local authorities, and representatives from residents and water users, and teach them to coordinate and work collaboratively;

River Basin Committee (RBC)

Platform to discuss and define the strategy for managing water resources in the river basin, in conformity with the national water management plan. Main responsibilities are:

- Advising central agencies on large water infrastructure projects;
- Defining main priorities for water management;
- Leading development and supervising implementation of RBMP;
- Coordinating and promoting water resource awareness and participation; and
- Forming ad-hoc working groups to discuss/study specific issues (possibly inviting outside parties and experts).

River Basin Agency (RBA)

Governmental agency responsible for water management under the supervision of the RBC. Main responsibilities are:

- Monitoring availability & uses of water resources;
- Planning strategic matching of supply & demand;
- Implementing the RBMP;
- Coordinating the allocation of water resources;
- Regulating withdrawals and releases;
- Implementing awareness and participation activities; and
- Managing risks such as floods and droughts, dam safety; and
- Possibly managing water infrastructure.

River Basin Management Plan (RBMP)

A realistic and focused 5-year Action Plan which:

- Presents a deliberate choice of activities to achieve specific goals, with clear implementation roles, allocated staff and resources, quantified targets and timetables, and monitoring mechanisms; and
- Is developed and implemented along with representatives of water users and residents, i.e. Municipalities, business/industrial associations, farmer groups and other non-governmental entities.

- Clarify roles and responsibilities and reduce overlaps and gaps;
- Ensure buy-in and commitment to the decisions; and
- Build capacity of all parties, improve performance and accountability.

3.4. WIDER PERSPECTIVE

The Middle-East & North Africa region acutely suffers from water scarcity. This is compounded by weak water management resulting in deficient water services and wide-spread pollution. Public health is negatively affected. Moreover, many socio-economic activities are significantly hampered; notably agriculture, which remains a large provider of jobs and is essential for food security.

In the context of climate change and of weak governance, the only development strategy to foster sustainable growth and political stability is to empower disenfranchised citizens (through Municipalities and local communities) to become stewards of their natural resources such as water resources. Empowered water users can positively challenge their government and demand better performance. They can also collaborate more willingly with local and regional authorities to ensure the success of water activities and projects, and collectively and individually adopt better water use practices, thus reversing negative trends.

A decentralized and effective River Basin Agency on the LRB that routinely collaborates with Municipalities and local communities could serve as a beacon of hope for civil society in Lebanon and more widely in the Middle-East.

4. COMPONENT 1: CAPACITY-BUILDING TOWARDS IRBM

4.1. OBJECTIVES AND EXPECTED OUTCOMES

4.1.1. OBJECTIVES AND COUNTERPART

The goals of this component were to:

- Improve the water governance framework that impacts and constrains day-to-day water management so as to ensure the success and sustainability of LRBMS technical activities (under all four components) and provide actual benefits to LRB water users.
- Build the capacity of LRA management and staff to handle water management functions beyond operation and maintenance of water infrastructure, chiefly the interactions with water users to raise their awareness of the impacts of their everyday practices on water resources and enforce withdrawal limits and release standards;
- Empower Municipalities and other non-governmental entities representing water users (such as farmers, industries, businesses: restaurants, hotels, tourism services, etc.) so as to facilitate water conflicts, address local water issues, and contribute to changing water use behaviors.

Counterparts for this component include the Litani River Authority, starting with its General Director and Board of Directors, but include also the Ministry of Energy and Water (MoEW), and by extension the entire GoL and the Parliament.

4.1.2. EXPECTED OUTCOMES

Expected outcomes included:

- Initial Assessment to assess:
  - The capacity of the LRA to carry out the tasks prescribed by its mandate;
  - The potential of LRA to evolve into an effective River Basin Agency with expanded water management responsibilities; and
  - The water governance framework (laws, institutions, policies) within which LRA operates.
- Improved water governance:

- Formation of Steering Committee;
- Recommendations for Integrated River Basin Management Study tours and workshops;
- River Basin Management Plan (Volume 1 Assessment & Volume 2 Action Plan);
- River Basin Decision Support System;

- Operational improvements of LRA:
  - Organizational and staffing plan for LRA to implement IRBM;
  - Operational systems/plans/tools developed for LRA and used;
  - Training activities for staff and for senior and mid-level managers on program management, financial management and planning, capital investment planning, and asset management, as well as O&M, outsourcing, and procurement;
  - Corporatization procedures and recommendations;
  - Modern management and financial systems;
  - Development of Business Plan;
- Knowledge development/awareness raising of water users:
  - Outreach and awareness sessions and materials for water users related to accountable/sustainable water use/management practices and to IRBM;
  - Economic analysis of water pollution impact and water valuation study; and
  - Feasibility study, design and construction of a pilot wetland scheme.

4.2. RESULTS

4.2.1. INITIAL ASSESSMENT

LRBMS first conducted an assessment of Lebanon's water governance framework (laws, institutions, policies) as well as of LRA's organizational and operational performance. The main findings were that:

- The LRA lacks legal authority over critical areas of water resource management that would be required to implement integrated river basin management (IRBM). The most critical elements missing from the LRA's current legal mandate are:
  - Management and allocation of water resources other than for irrigation and hydropower;
  - Groundwater management.;
  - Awareness raising and enforcement of water rights and regulations;
- The organizational structure and staffing of LRA are adequate for its current missions and probably insufficient to carry out water resources management activities;
- Most of the executive decision power of LRA resides with the Board of Directors or even higher at the levels of the MoEW, the MoF, or the Council of Ministers when it should be delegated to

the General Director; conversely none of these entities provides strategic vision to guide water resources planning and management; and

- The legal basis for stakeholder participation in water management is at best unclear.

The initial assessment, while administratively under component 1, also included a review of the water monitoring, irrigation management, and risk management capacities of LRA to guide the three other, more technical, components of LRBMS (the initial findings are presented in the following chapters covering components 2, 3, and 4).

4.2.2. IMPROVED WATER GOVERNANCE ACHIEVEMENTS

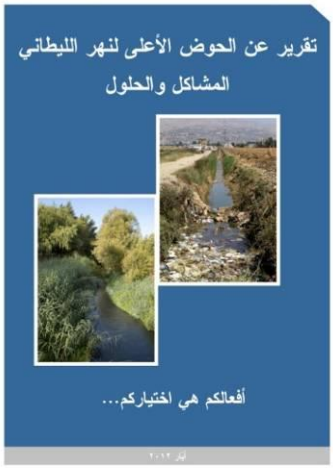
LRBMS first proposed to the LRA Board a one-page vision statement to endorse IRBM. This was followed by a report exploring the future water management role of the LRA, and a revised legal mandate for LRA to handle IRBM functions such as enforcement of water authorizations (for withdrawals and releases), awareness activities, as well as riverbed maintenance and flood management. LRBMS also prepared an Action Plan for LRA to initiate the implementation of both awareness and water enforcement activities in the LRB.

In parallel LRBMS prepared a River Basin Assessment which was presented to LRA and Municipality representatives to mobilize them and encourage them to promote better water use practices among their constituents. The River Basin Assessment notably included:

- A walk-through with over 100 pictures to illustrate the many pollutions and abuses water resources suffer from;
- A quantitative river basin balance to show current and future water needs and availabilities; and
- Three basin-wide water quality surveys (see component 2) to assess the magnitude of current sources of pollution.

This assessment was endorsed by twenty Litani River Basin Municipalities as the first volume (baseline assessment) towards a River Basin Management Plan.

Endorsement of RBMP volume 1 -assessment



In October 2012, a study tour was organized to France for nine Mayors and four LRA staff to experience participatory decentralized water management. Discussions with French River Basin Committees highlighted the leading role of Mayors and Water User Representatives to address water pollution issues and water use conflicts, and plan integrated water management activities, from construction to operation to enforcement and awareness raising.

Study Tour to France: visit of water awareness center

Study Tour to France: meeting with River Basin Committee (Mayors)

Study Tour to France: visit of wetland managed by Municipality

Upon return to Lebanon, these Mayors mobilized as a group and advocated the need for action to their national leaders. Meetings were held under the leadership of Nabih Berri, Speaker of the Parliament, to specifically discuss water issues in the Litani River Basin. These meetings involved more than twenty Mayors along with representatives from relevant Ministries (Water and Energy, Environment, Agriculture, Industry, and Interior) and the Litani River Authority (LRA).

As a result, a Program-Law[3] was prepared to address water pollution in the LRB and officially submitted in January 2013 to the Council of Ministers. This Programming Law requests the implementation of an exhaustive set of water projects and activities (for a total of $240 M or so). Implementation is to be supervised by a permanent Litani River Committee involving

H.E. Nabih Berri leading discussion on Litani River Basin with Bekaa Mayors (Nov. 24, 2012) (Source: National News Agency)

[3] Said Program-Law was prepared by Ministry of Environment in cooperation with other GoL agencies and chiefly the LRA. This Law is still under review by Parliament and its text is thus not yet publicly available.

representatives from relevant Ministries along with six Mayors, with LRA as the coordinating agency. This Program-Law is now under review by the Parliament.

In parallel, LRBMS prepared a pragmatic River Basin Management Plan that is an achievable 5-year action plan with an integrated set of 36 actions covering infrastructure development, monitoring, enforcement, and awareness raising to address quality, quantity and governance issues. This RBMP is more focused than the Program-Law and mostly aims at starting the process of IRBM with realistic objectives as it is done in most of Europe under the Water Framework Directive. This RBMP was also endorsed by twenty LRB Municipalities.

		Infrastructure	Monitoring / Enforcement	Awareness / Participation
Governance				
QuaLity	URban sewage			
	Industrial sewage			
	Solid Waste			
	Agriculture			
QuanTity				

Water Management is more than just construction! The Integrated approach calls for different types of activities.

LRBMS also assisted the formation of a water federation of LRB Municipalities[4] for these to:

- Pool resources, such as staff, capacity, and funds, and achieve economies of scale;
- Coordinate their actions;
- Jointly implement awareness raising and concrete activities; and
- Advocate to central authorities for involving LRB Municipalities in water management.

A second study tour was consequently organized in February 2014, again taking ten LRB Mayors and some LRA staff to France to interact with French River Basin Committees. A partnership letter of intent (first step towards collaboration) was signed with RES' Eau 34, a new association grouping eleven river basin committees around Montpellier in France.

2nd Study Tour to France: teamwork with LRB Mayors and LRA staff

2nd Study Tour to France: partnership signing with RES'Eau 34

[4] LRB Municipalities in the Water Federation are Anjar, Baalbeck, Bar Elias, Ferzol, Joub Jenine, Marj, Qaraoun, Saghbine, and Zahle,

4.2.3. OPERATIONAL IMPROVEMENTS AND CAPACITY-BUILDING OF LRA

Based on the findings of the initial assessment, LRBMS proposed to upgrade the financial system as well as the data/communication networks. LRBMS accordingly provided LRA with five new servers and software for communication, file sharing and backups. Corresponding training (network management, server operation & maintenance) was delivered to the LRA IT Unit. LRA's financial/accounting system was also upgraded to an integrated software (ERP) which consolidates all financial transactions, simplifies data entry, proposes multiple reporting options, and reduces human errors.

IT staff attending training session on Windows Server

In terms of business planning, LRBMS prepared a financial forecasting tool (under Excel) to assess LRA's future revenues and expenses (notably considering future large water projects such as Awali-Beirut and Canal 800 that will impact LRA revenues).

The main training courses and presentations provided to LRA were the following:

Title	Date	Title	Date
Initial Assessment	November 2009	Enterprise Resource Planning (Financial Management Software)	June 2012
IRBM Vision of the LRB	January & May 2010	Awareness Campaign	July 2012
Windows Server	July 2010 - May 2011	Financial Management Assessment	September 2012
Windows Exchange	March - April 2011	Accounting Software	December 2012 - March 2013
Windows Forefront	July 2011	Wetland O&M	December 4, 2013
Litani River Walk-Through	August 2011	Financial Management	May 2013
IRBM principles and concrete steps	January 2012	Financial Forecasting	May 2013
Wetlands – Concept and benefits	February 2012	Human Resources Needs Assessment	May 2013
Design of Wetland	May 2012		

A Human Resource Needs Assessment was carried out within LRA in May 2013 through interviews with managers and staff. Findings were that:

- Most departments and units are responsible for generic tasks and do not have specific/annual goals; consequently their performance is rather poor (and unmonitored);

- Staff is abundant but at low, unskilled levels, while managers are few (the five top positions are filled by two 'acting' directors);
- Most staff have vague "job descriptions", and again no specific/annual goals; they receive limited guidance; promotions are based on political considerations while rewards (such as paid overtime) are conferred regardless of actual performance (which is unmonitored);
- Annual report produced by LRA presents, for each unit/department their generic mandate with few figures reflecting actual achievements.

Human Resources management being a sensitive topic, LRA would only agree to generic staff training courses (time management, writing skills, etc.) but consistently ignored any offer to build capacity in staff management, corporate culture, or performance monitoring.

4.2.4. KNOWLEDGE DEVELOPMENT/AWARENESS RAISING OF WATER USERS

LRBMS carried out several awareness activities targeting all types of water users, using billboards, posters and brochures, to increase their understanding of water pollutions and wastages. Awareness and participation activities are covered in several technical reports, for example the "Water Awareness Campaign" and "Support to Collaborative Activities" reports which are listed in the next section (4.2.5). Activities include:

- A drawing contest was organized in elementary schools of the LRB and a 2012 calendar was produced using the best twenty-six drawings that were rewarded during a ceremony involving LRA and USAID officials; 7000 calendars and 3000 activity booklets on water pollution were also distributed to elementary school students;
- Five posters were designed, showing the circularity of the water cycle, and the impact of the four main types of water pollution (agricultural, industrial, wastewater and solid waste) and encouraging responsible behaviors; these posters were used on billboards in a wide campaign lasting several weeks all over the LRB;
- Five brochures were then produced to describe "Do's" and "Dont's" behaviors that residents and water users can individually and collectively adopt to mitigate the four types of water pollutions (about 10,000 brochures have been distributed);
- 7,000 notebooks using these same brochures were also produced and distributed to elementary school students; and
- Finally a 1.5-hour puppet show was delivered 40 times to about 3,000 school students, while a 20-min documentary was prepared to present LRBMS approach and achievements.

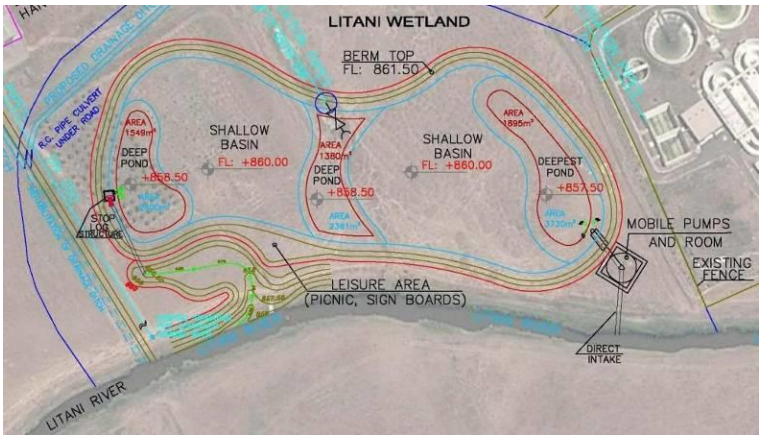
10-y old Siraj Janbai explaining the pollution of Litani River from his prize-winning drawing

LRBMS also supported community activities such as river clean-ups in the towns of Anjar (where it has become an annual event for 3 years going), Baalbeck, Joub Jenine, Kfarzabad, Marj, Qaraoun, and Saghbine. The goal was to involve residents and water users in the design, planning, and implementation of concrete local scale activities solving water issues, and thus turn them from passive beneficiaries into informed actors through this "learning by doing" approach.

Brochure showing the impact of water pollutions and suggesting individual/collective DOs/DONTs

Residents from the town of Anjar mobilize for the second annual clean up of the Ghzayel river (Fall 2012)

Finally, LRBMS built a 3-ha pilot wetland to treat waters from the Litani River (which in summer are mostly raw sewage), raise awareness of residents about pollution and natural wastewater treatment solutions, and provide a habitat for wildlife. Energy is supplied by solar panels, minimal supervision is required from LRA staff to operate this wetland. This pilot wetland is meant to be a low maintenance wastewater treatment alternative to the many wastewater treatment plants built in Lebanon and who often do not operate due to lack of funding and



Growth of native reeds

Initial filling of the wetland

4.2.5. MAIN TECHNICAL REPORTS

The following technical reports were produced under Component 1 and posted on USAID DEC:

Initial Assessment Report	February 2010

Improved water governance

The Role of LRA: Present and Future	July 2010
Restructuring the Litani River Authority	May 2012
RBMP vol 1 - Assessment (also a summary version, both in English & Arabic)	May 2012
RBMP vol 2 - Action Plan (also a summary version, both in English & Arabic)	April 2013
Establishing a Water Federation of Litani Municipalities	September 2013
Action Plan for Water Resources Awareness and enforcement	January 2014

Operational Improvements of LRA

Upgrading LRA Financial System - Assessment	February 2012
HR Needs Assessment	April 2013
Financial Forecasting Model	September 2013
Upgrading LRA Financial System - Final Report	March 2014

Knowledge development/awareness raising of water users

Walk-Through Report (English & Arabic)	October 2011
Water Balance	December 2011
Water Awareness Campaign	March 2012
Economic Assessment of Water Use and Water Pollution	May 2012
Knowledge Assessment Survey	July 2012
Support to Collaborative Activities	November 2013

Construction of pilot wetland:

Wetland Feasibility Study	February 2012
Wetland Design	May 2012
Wetland O&M Manual (English & Arabic)	August 2013

4.2.6. SUCCESS STORIES PROVIDED TO USAID

The impact of LRBMS activities under Component 1 was notably captured through success stories:

- January 2011: Litani Water Users Work Together on Actions to Overcome Water Challenges
- April 2011: Improving the Litani River Authority's IT Infrastructure and Capacity
- April 2011: Bekaa Municipalities Discuss the Litani River Water Issues
- October 2011: Bekaa Municipalities form a Litani River Municipal Committee
- October 2011: A Cleaner Water Spring
- February 2012: Improving Children Understanding of the Impact of Litani River Pollution
- March 2012: USAID Rewards Students for Drawings and Writings on Water Pollution
- September 2012: Bekaa Municipalities Endorse Litani River Basin Assessment
- October 2012: Bekaa Mayors' Water Management Study Tour to France
- October 2012: Second Annual Ghzayel River Clean-up Campaign
- March 2013: Water Management Study Tour Emboldens Litani Mayors to Ask for Action
- April 2013: USAID's LRBMS Assists the Upgrade of LRA Accounting System
- June 2013: USAID Raises Awareness of Litani Children on Water Issues through Puppet Show

4.3. PROBLEMS AND LESSONS LEARNED

4.3.1. INVOLVEMENT OF MEW

The LRBMS project was initially designed and negotiated directly between USAID and LRA, as it is legally feasible due to LRA's administrative autonomy. Early 2010, the new Minister of Energy and Water requested for MEW to be USAID's counterpart on the project. Unfortunately there has been limited collaboration between MEW and LRA due to internal conflicts between the two entities. Within that context, it has been difficult and even counter-productive to engage MEW.

Due to MEW's disengagement, the mobilization of civil society (and private sector) was the remaining channel to promote IRBM in Lebanon. LRBMS did successfully engage Municipalities, less so private sector (industries, farmers) and NGOs, where interested and representative partners were not found.

4.3.2. OBSTACLES TO LRBMS ACTIVITIES

Several key issues were identified early on as hampering the progress, impact, and sustainability of LRBMS activities meant to support the transition of LRA towards Integrated River Basin Management:

- Data access and quality: LRA was initially reluctant to provide reports and water data due to concerns over maintaining confidentiality of what is considered sensitive data (for reasons of

"national security"); this issue was addressed by building trust with LRA and through time-consuming collection of field data;

- Insufficient LRA staffing and staff capacity: LRA employs about 250 staff (half permanent, half contract staff), but less than twenty can be considered technically qualified workers (engineers, technicians, accountants); as a consequence, involving LRA staff in LRBMS activities to ensure ownership and sustainability has been a challenge; upon initial request from LRBMS, a "Component Committee" was set up as counterpart; due to lack of attendance (supposedly due to heavy workloads), lack of motivation, and sometimes in-fighting, these committees were discontinued; LRBMS instead engaged LRA staff activity by activity (for example accounting department for upgrade of financial system, IT unit for upgrade of website, etc.); on the positive side, LRBMS was extremely fortunate to have Dr Nabil Amacha appointed by LRA as main contact person;
- Reluctance to change and lack of leadership: as mentioned before, the acting status of both LRA General Director and LRA Board prevents leadership and strategic decision making at LRA level; the top-down centralized management prevents LRA from operating autonomously, as it legally should.

4.3.3. OBSTACLES TO ADOPTION OF IRBM

Several systemic/governance issues prevent the adoption of IRBM in Lebanon. The approach is being discussed in Lebanon (for example in the draft Water Code prepared with support from French Aid AFD) but not really endorsed. As mentioned earlier (section 2.4), the focus for most decision-makers (starting with MEW) remains on engineering projects and constructions as being tangible/visible outcomes, while management reforms are avoided as more difficult, even if much cheaper and often more efficient.

Weak water governance was summarized by the World Bank in its 2012 Country Water Sector Assistance Strategy for Lebanon, with four key constraints:

(1) "Weak accountability is likely to dull the impact of other measures and investments unless priority is given to improvement measures that will clarify the respective obligations and rights of public agencies for the delivery of water services and empower the Regional Water Establishments.
(2) Investment needs to be reconciled with fiscal realities, linked to key reforms, and targeted at priority outcomes.

(3) Improvements in investment and operational efficiency depend on restructuring and building implementation capacity in a practical, prioritized way.
(4) Increasing ownership of sector reform – and reflecting back stakeholder concerns and political economy realities into fine-tuning the National Water Sector Strategy - is important."

These can be summarized as: weak performance and unclear roles/responsibilities in the water sector, lack of focus (no prioritization) and unrealistic planning (much beyond possible funding), lack of coordination and capacity among water agencies, and lack of water user participation.

Within the IRBM approach for the LRB, LRBMS proposed to address these four issues through:

- Clear delegation to LRA of water management functions (for example in terms of awareness and enforcement of water withdrawals/releases);
- Drafting of a focused and realistic 5-year River Basin Management Plan;
- Implementation of this Action Plan under the supervision of a coordinating Litani River Basin Committee involving both water agencies and Municipalities; and
- Mobilizing water users through awareness raising and collaborative activities (such as river cleanups) to generate stewardship and promote appropriate water use practice; and engaging Municipalities to play a more active role in this process.

4.3.4. LESSONS LEARNED

Institutional reform and policy change need champions, both at local and central level to assist and sustain the effort. Since 2010 (shortly after LRBMS start) the focus of the Minister of Energy and Water from early 2010) has been on the infrastructure development part of the National Water Sector Strategy. Lesser attention has been given to essential water management functions such as allocation, enforcement (of withdrawal limits and release standards), awareness raising. Due to the political context, little also has been achieved in terms of clarification of roles/responsibilities, horizontal and vertical coordination, and finally delegation or decentralization.

Change can come from central level leadership or through the mobilization of people and local leaders. In Lebanon, only the latter seems possible, and LRBMS should probably have focused earlier and more heavily on raising awareness and empowering Mayors and other local leaders representing water users (factories, businesses, farmers, residents, etc.).

4.4. SUSTAINABILITY AND SUGGESTED FOLLOW-UP

4.4.1. SUSTAINABILITY

The sustainability of LRBMS technical activities (upgrade of financial system, construction of wetland) will rely, in the absence of internal or external accountability, on the good will of LRA managers and staff which cannot be predicted.

The promotion of IRBM under LRBMS has reached its first outcomes, with the:

- Drafting of a Program-Law acknowledging the need for basin planning, establishing a Litani River Basin Committee and appointing LRA as the coordinating/implementing agency; however this Law has yet to be promulgated;
- Engagement of local leaders through a Water Federation of Litani Municipalities; this Federation will need both leadership and support to develop into an effective platform;
- Preparation of a focused and realistically achievable River Basin Management Plan (already endorsed by Municipalities); and
- Mobilization of residents/water users through local activities such as river cleanups so as to build stewardship.

But institutional change and policy reform take time, and two project cycles (4-5 years each) are a minimum to achieve lasting progress. The dissemination of IRBM principles will hopefully continue, especially if international donors make it a pre-requisite to their funding and technical assistance programs (like AFD is currently doing when demanding the promulgation of the Water Code).

4.4.2. FOLLOW-UP THEMES

4.4.2.1. AWARENESS RAISING

A follow-up to LRBMS should thus be considered by USAID, given some buy-in from MEW, LRA, Municipalities, and/or civil society/private sector entities. As mentioned above, the three main obstacles to effective and sustainable management of water resources are:

- Wastages and pollutions caused by ignorant and selfish water users;
- Poor performance by water agencies; and
- Decision-makers who focus solely on infrastructure solutions because of ignorance, incompetence, or personal gain.

The main approach to developing citizenship/stewardship, and improving governmental performance and policy making is awareness raising. A sustained national water awareness effort should be considered, with the idea of not only changing water use practices, but also making awareness raising a

sustainable, permanent, and significant activity of water agencies. This would only happen after changing mentalities of most water managers and policy-makers who do not understand the importance and potential impact of awareness raising.

Enforcement of water regulations should also been investigated, as it is the logical complement to awareness raising to change water use practices, and notably address abuses such as polluting releases and unauthorized withdrawals or over- extraction.

4.4.2.2. PARTICIPATION

As all education specialists know, the best learning approach is "learning by doing". Having water users directly involved (in river clean-ups, individual and collective actions around water use efficiency and pollution mitigation) would sensitize them to the impact of their daily behaviors and prompt many to change. At the next level, having local leaders (farmer representatives, Mayors, etc) be empowered with some resources and authority to tackle local water issues would allow better, more transparent and accountable resolution of such issues.

Participation

Empowering (usually disenfranchised) citizens and local leaders is the key to change in Lebanon as it is in the rest of Middle-east. Empowering is meant here in the sense of building citizenship i.e. first ensuring the right for water users to be heard and involved in planning, design, and implementation of water projects and activities, and second the duty to be held, individually and/or collectively, accountable for the impacts of their actions.

Possible local water activities to be supported are:

- Industrial pollution:
  - Dialogue between municipalities and polluting factories to consider steps to install pre-treatment and eventually complete mitigation of pollution
  - Small construction works to pre-treat industrial effluents
  - Leadership of Chamber of Industry/Commerce to design award system for "green/good factories"
- Domestic sewage pollution:
  - Rapid but annual assessment of the operating status of wastewater treatment plants
  - Rapid but annual update on the level (per municipality) of connection to sewage network
  - Local construction works on the sewage network
- Solid waste pollution:
  - Annual review (per municipality) of garbage collection and disposal processes
  - Simple incentive schemes to promote recycling
  - Small construction works to improve dumpsites
  - River/canal clean up activities (by residents)
  - Development of walking paths along waterways
- Agriculture:
  - Simple incentive schemes to promote soil analysis and prevent fertilizer over-use
  - Review of functioning of local Water Committees (irrigation), definition of simple allocation/pricing rules to better use irrigation water and solve conflicts

- Flood risk mitigation:
    - Annual (Fall) riverbed maintenance to maintain conveyance capacity of channels and sluices (e.g. removing irrigation diversion dams and other infringements)
    - Small construction works on riverbanks to prevent riverbed obstructions
- Urban planning:
    - Partnership with LRA to define floodable areas and better plan urban development
    - Simple measures (fencing and posting) to protect springs and water supply sources from contamination from garbage, livestock, etc.

4.4.2.3. RIVER BASIN PLANNING AND DECENTRALIZATION

Integrated River Basin Planning is now the water management approach in Europe as decided and guided by the 2005 European Water Framework Directive. As described in chapter 3, this approach significantly improves the effectiveness and efficiency of water management.

Decision-making is heavily centralized in the top-down hierarchical systems that prevail in Lebanon and in the Middle-East. Centralization does not improve performance as it tends to hide decision-making from citizens, increase the negative impacts of poor decision-making, and increase corruption (in volume if not in number of acts). Conversely delegation improves decision-making, makes it more field-based, and more accountable as it allows more oversight from citizens, and again allows learning by doing.

IRBM, because it is decentralized, allows:

- Central decision-makers to focus on strategic decision planning, legal reform, guidance and regulation (for example regulation and performance monitoring of Water Establishments); and
- Regional/local decision-makers to take local decisions guided by a clear legal and technical framework and in direct contact with residents and water users.

This approach forces local interests/stakeholders (residents, businesses, factories, farmers, etc.) to convene and negotiate to reach common decisions, instead of resorting to central refereeing and shadowy/back channels to exert influence on decision-making processes.

Currently in Lebanon, coordination between central agencies (horizontal coordination) and between central and regional/local entities (vertical coordination) is token at best if not absent. Reinforcing these links should be a pre-requisite of all donor projects.

5. COMPONENT 2: LONG-TERM WATER MONITORING

5.1. OBJECTIVES AND EXPECTED OUTCOMES

5.1.1. OBJECTIVES AND COUNTERPART

Sound management rests on reliable information. Water managers and water users in the Litani River Basin can take better decisions when provided with reasonably accurate water information on the status of surface- and ground-waters, both quantitatively and qualitatively.

The LRA carries out water quality monitoring in the Litani River Basin and has also became responsible for water flow monitoring country-wide. The objective of this component was to improve the collection, quality control, storage, and dissemination of water data in the Litani River Basin, in terms of both quality and quantity, and addressing both surface and groundwater. Within the LRA, the main partners for these activities were the Environment Unit and the LRA Water Resources Department, which have been monitoring water resources in the LRB and all over Lebanon for many years.

5.1.2. EXPECTED OUTCOMES

Expected outcomes included:

- Improved surface water monitoring, through the procurement and installation of water quality monitoring equipment and modern gauging stations, and technical assistance to the collection, processing, quality control, storage, and dissemination of surface water data;
- Initiated groundwater monitoring through the procurement and installation of observation wells, and technical assistance to the collection, processing, quality control, storage, and dissemination of groundwater data;
- Enhanced data management, with:
    - Improved databases and reporting tools
    - Improved procedures for assessment of water use and water use efficiency
    - Water Monitoring Plan (including procedures for data collection, control, storage, analysis); and

- Training sessions and workshops on data quality control, data analysis, and interpretation.

5.2. RESULTS

5.2.1. INITIAL ASSESSMENT

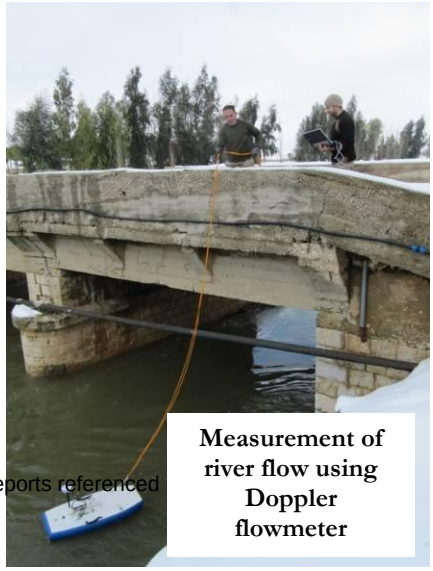
LRBMS first conducted an assessment of LRA's water monitoring capacity. The main findings were that:

- Human activities (mostly the direct disposal of untreated sewage and industrial effluents into surface watercourses, and the excessive use of fertilizers and pesticides by farmers) are degrading the quality of water resources in the Litani River Basin.
- LRA has a national mandate to monitor river flows and also conducts water quality monitoring activities in the Litani River Basin.
- Most of the resulting water data is:
  - Recorded and stored under Excel spreadsheets which are ill-adapted for this purpose;
  - Of uncertain quality;
  - Not easily accessible; and
  - Seldom used by decision makers (field managers and policy makers) and water users (such as farmers and residents whose wellbeing and incomes are impacted by the quality and availability of water resources).

5.2.2. SURFACE WATER ACHIEVEMENTS

LRBMS provided water monitoring equipment (quality meters, flow meters), and installed five automated gauging stations for routine quality and quantity monitoring of the Litani River and tributaries[5]. Corresponding training was also delivered to LRA staff. LRBMS upgraded (from DOC to Windows) the HYDATA database used for storing water quantity data for all Lebanese gauging stations.

Installation of sensor in new gauging station



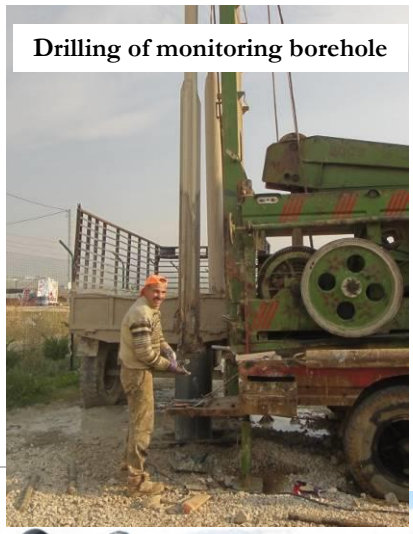
Measurement of river flow using Doppler flowmeter

5 [illegible] rovided in the reports referenced [illegible] the report "Installation of Surface and Groundwater Monitoring Stations"

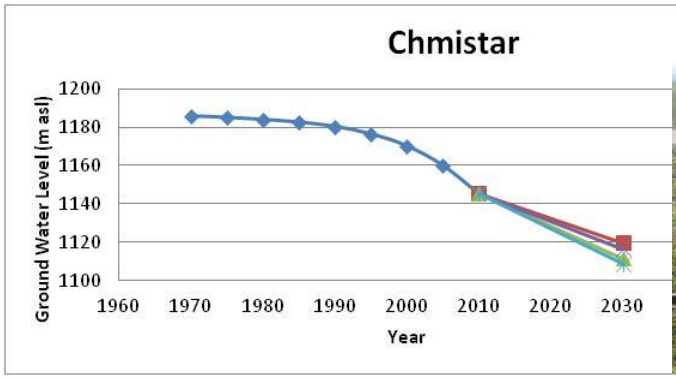
5.2.3. GROUNDWATER ACHIEVEMENTS

LRBMS also initiated groundwater monitoring by installing fourteen automated observation wells to routinely collect qualitative and quantitative data on the LRB aquifers[6]. A groundwater computer model of the Litani River Basin (using the MODFLOW software) was also developed to better understand the groundwater situation, forecast future levels, and test management strategies.

LRBMS provided all corresponding capacity building for LRA staff to operate and maintain water monitoring equipment.



Drilling of monitoring borehole



Forecasting of future groundwater levels

Data collection from newly equipped well

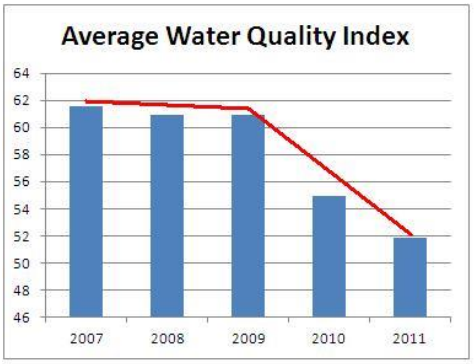
5.2.4. DATA MANAGEMENT ACHIEVEMENTS

LRBMS assisted the digitizing of all archives and compiled all Geographic Information Systems existing at LRA into one system, installed on a central server. Specific databases and satellite imagery were also purchased to augment this GIS. A scanner was procured, and thousands of archive maps and documents were sorted and added to the LRA GIS. LRBMS also assisted LRA staff to streamline data management processes (collection, quality control, storage, analysis, dissemination) and prepared a Water Management Plan. LRBMS finally conducted a land use analysis based on satellite imagery to assess current water use in the LRB.

Data Management: before and after

[6] Further details including maps and locations of the installed stations is provided in the reports referenced in section 5.2.6, notably the report "Installation of Surface and Groundwater Monitoring Stations" and "Expansion of the Groundwater Monitoring Network"

Information bulletins based on a water quality index (aggregating several water quality indicators) were also prepared for LRA to disseminate water quality results to Bekaa Municipalities and residents on a monthly basis.



5.2.5. CAPACITY-BUILDING ACTIVITIES

The main training courses and presentations provided to LRA were the following:

Title	Date	Title	Date
Principles of GIS	March 2010	Flow Measurement using River Surveyor	July 2011
Water Quality Monitoring	May 2010	Surface Water Stations	July - September 2011
O&M of Water Monitoring Equipment	December 2010	Water Monitoring Equipment	September 2011
Principles of Water Gauging Stations	January 2011	Ground Water Monitoring	May 2011
Water Quality Impacts	March 2011	Water Quality Review	November 2011
Compiled GIS	March 2011	Ground Water Modeling	January 2014
HYDATA Database	May 2011		

5.2.6. MAIN TECHNICAL REPORTS

The following technical reports were produced under Component 2 and posted on USAID DEC:

Water Quality Survey I - Dry Season (summer 2010)	February 2011
Water Quality Survey II - Wet Season (winter 2011)	September 2011
Hydrogeologic Reference of the LRB	April 2012
Installation of Surface and Groundwater Monitoring Stations	August 2012
Water Quality Survey III (summer 2013) + Water Quality Index	September 2013
Ground Water Modeling of the LRB	October 2013
Expansion of the Groundwater Monitoring Network	October 2013

5.2.7. SUCCESS STORIES PROVIDED TO USAID

The impact of LRBMS activities under Component 2 was notably captured through success stories:

- April 2010: GIS Development for the Litani River Authority

- January 2011: Technology Preserves Key Water Maps
- June 2011: HYDATA Training Leads to Better Management of Water Data at LRA

5.3. PROBLEMS AND LESSONS LEARNED

As mentioned earlier, data access proved a sensitive topic at the onset of LRBMS. Trusting relationships were established with the counterpart staff and data access was then reasonably good throughout the program duration.

The quality of any product depends on its clientele (poor products have to improve or get ignored), and this is also true with data. LRA is the main Lebanese agency collecting and producing water data, but most of it is of uncertain quality (especially the quantitative data on river flows). The main reason is the lack of interest from both decision makers and Lebanese people at large. Decision makers only consider data that fits their preconceptions, projects, or plans, and conveniently ignore any disagreeing data that may lead them to question/revise their decision-making. Lebanese people mostly face raw scientific data which they cannot understand, and rarely pedagogic information meant to educate them, and guide their behaviors. The quality of water data will not improve in Lebanon until people ask for reliable and accurate information while decision makers acknowledge the necessity to base decisions on data.

Data management is like any other management activity, it requires efficient use of resources in terms of staff, equipment, and other resources. LRA, like often in the public sector in general and particularly in Lebanon, does not provide its staff, managers, and departments with specific scopes of work (beyond vague job descriptions) or clear annual goals to monitor performance and progress. This specifically applies to the LRA Water Resource Department, who suffers from lack of staff and management capacity. As a consequence, the technical capacity-building provided by LRBMS has been hampered by managerial inertia and resistance to change. Local champions such as Dr Nabil Amacha at LRA were very helpful to achieve lasting improvements.

5.4. SUSTAINABILITY AND SUGGESTED FOLLOW-UP

5.4.1. SUSTAINABILITY

The sustainability of LRBMS activities under component 2 (procurement of equipment, upgrade of GIS and databases, capacity-building) will rely, in the absence of internal or external accountability, on the good will of LRA managers and staff which cannot be predicted.

5.4.2. FOLLOW-UP THEMES

5.4.2.1. DATA DISSEMINATION

As mentioned above, the reliability of water data will only improve if there is a demand from both people and decision makers for such data. Only checked/consulted data improves over time. Efforts should be made to continue supporting the collection, quality control, and analysis of water data and the dissemination of water information. Conversely awareness raising requires data to support its promotion of good water use practices and enforcement as well to prevent harmful behaviors.

5.4.2.2. FLOW MEASUREMENT

Efforts to improve the flow measurement practices at LRA have been limited due to usual resistance to change. Technical assistance is then much needed, for the LRB and nationally, to:

- Assess all operating gauging stations, discard the (many) inappropriate/dysfunctional ones and validate the reliable ones;
- Review flow measurement procedures, and the rating curves used for the translation of water levels into discharges;
- Improve the collection and dissemination of precipitation data (currently secretively handled by the Civil Aviation but expensive/difficult to obtain);
- Establish a national website where all flow measurements and rain data would be posted on a monthly or quarterly basis.

5.4.2.3. GROUNDWATER MANAGEMENT

Groundwater is the hidden part of the water cycle. The situation of groundwater resources is steadily degrading in the LRB, in terms of both quantity and quality. Serious efforts are needed to better:

- Understand and monitor current uses, and inventory existing wells;
- Model current and future evolutions of the main LRB aquifers;
- Inform groundwater users (mostly farmers) about the situation;
- Promote and encourage efficient irrigation (notably through effective agricultural extension services, see component 3 below).

6. COMPONENT 3: PARTICIPATORY IRRIGATION MANAGEMENT

6.1. OBJECTIVES AND EXPECTED OUTCOMES

6.1.1. OBJECTIVES AND COUNTERPART

Irrigation uses a large share of water resources in the Litani River Basin and heavily draws from groundwater. The sustainability of irrigation in the Litani River basin is uncertain due to groundwater depletion, inefficient use of water, over-use of fertilizers and pesticides which contaminate water resources, and widespread use of raw sewage for irrigation, with obvious contamination hazards from organic pathogens and chemicals.

The objective of this component was to improve irrigation practices and specifically increase water use efficiency. Focus here was on the pilot Canal 900, a pressure network and the only modern irrigation system in Lebanon completed in 2000 under World Bank funding and meant to directly supply sprinkler systems. This system is supplied from Qaraoun Lake and managed by LRA.
A side activity was the construction of a freshwater pipeline to provide supplemental irrigation in summer to an irrigated area in Machghara, just below Qaraoun Dam.

The counterpart for this component was the LRA staff posted on Canal 900 and the Department for Rural Development.

6.1.2. EXPECTED OUTCOMES

The initial approach for this component was, within the West Bekaa project (Canal 900), to select a pilot area with LRA, implement structural, operational and managerial improvements in that pilot area, improve irrigation and agricultural practices, engage farmers and eventually ensure a transfer of management responsibilities for that area to them.

After a thorough analysis of the issues facing the canal 900 network (which in its current pilot stage should serve about 1800 ha but actually supplies only 600+ ha), LRBMS reached the conclusion that very limited improvements can be implemented in a sustainable manner in the Canal 900 area if key structural and operational deficiencies are not addressed first, along with strengthening LRA-farmer relationship. Expected outcomes for this component thus became:

- Improved O&M of Canal 900 system;
- Rationalization of Agricultural Practices; and
- Participatory Irrigation Management, i.e. better coordination between LRA and farmers.

6.2. RESULTS

6.2.1. INITIAL ASSESSMENT

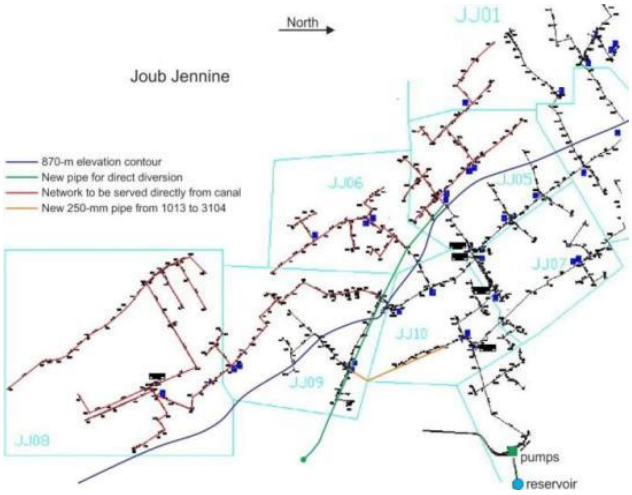
LRBMS first conducted an assessment of LRA's irrigation management capacity and of the situation of irrigation in the LRB. The main findings were that:

- The mandate of LRA specifically involves the task of studying new irrigation projects and managing them in all of Southern Lebanon and South Bekaa.
- LRA manages the first (pilot) part of the Canal 900 network to deliver pressured irrigation water to 1800 ha of agricultural lands around Joub Jenine; sprinkler (for wheat, potatoes, corn) and drip (for vegetables) are the LRA-mandated irrigation methods;
- Serious design and construction deficiencies prevent the system from serving effectively more than 600 ha (water needs were estimated very low, based on experimental deficit irrigation practices which require scientific expertise to be successful);
- Relationships between farmers and governmental employees are at best distrustful if not antagonistic;
- A Water User Association (WUA) was previously established by the EC-funded IRWA project in the Canal 900 area but is not functional and distrusted both by LRA field staff (not involved in the WUA formation, centrally led by LRA Rural Development Department) and farmers (who have little trust in each other and consider that the WUA Board involves landlords not famers);
- A new, sophisticated and fully functional soil and water testing laboratory (LRA Kherbet Kanafar Extension Service Center) was provided by IRWA; lack of political will, internal LRA conflicts, and shortage of qualified staff severely restricts the activities of that center;
- Most farmers receive fertilizers, pesticides, and other inputs from agricultural dealers who encourage over-application and get paid through sharecropping at discounted prices; and

- Farmers tend to over-irrigate, even those using drip and sprinkler irrigation, as they have limited, if any, notion of irrigation scheduling.

6.2.2. OPTIMIZATION OF CANAL 900 NETWORK

LRBMS reviewed operational and maintenance activities for Canal 900 and suggested improvements through the development of an O&M plan. Serious structural issues (due to weak design and construction) were also identified on the Canal 900 system and led LRBMS to procure and install O&M equipments (valves, airvents, flow-meters) and build two gravity diversions to increase the served area. LRBMS also provided all corresponding capacity building for LRA staff to operate and maintain this equipment. A computer model of the network (EPANET software) was developed and used to optimize water delivery and also assist the design of the two gravity diversions that can each supply about 250 ha previously underserved.



Design, construction and test of new gravity diversions

6.2.3. RATIONALIZATION OF AGRICULTURAL PRACTICES

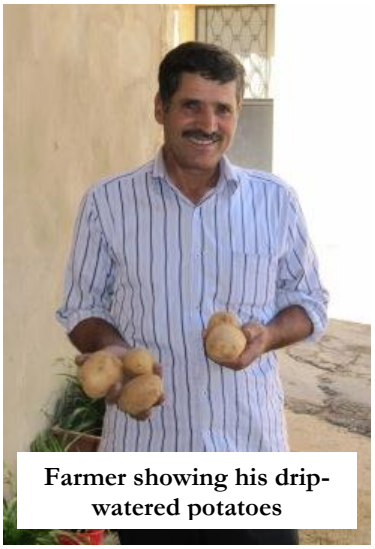
LRBMS engaged farmers to raise awareness on water pollution and water use efficiency issues. An exhaustive training program was developed and implemented with the following themes:

- On-farm water management and irrigation scheduling;
- Soil management, rational use of fertilizers and pesticides; and
- Modern irrigation and crop production.

Installation of drip irrigation equipment

A specific demonstration program was implemented to promote the use of drip/micro-sprinkler irrigation equipment (which was procured to willing potato farmers) to increase water use efficiency and improve incomes through decreased labor and increased yields.

LRBMS also supported the revival of soil and water analyses at the LRA Kherbet Hanafar agricultural extension center.



Farmer showing his drip-watered potatoes

6.2.4. PARTICIPATORY IRRIGATION MANAGEMENT

The idea of WUA was initially poorly received (and understood) by both farmers and LRA staff on Canal 900, due the previous bad experience (as explained above under 6.2.1).

LRBMS facilitated meetings first among farmers, then between LRA staff and farmers to promote dialogue and improve internal and external collaboration. Common site visits were also organized, and a Canal 900 Committee was formed with farmer representatives from each of the six towns and villages served by the system. The Canal 900 Farmer committee is an informal committee formed of one farmer chosen by his peers for each of the villages served by the system: Qaraoun, Lala, Balool, Kamed Loz, and Saghbine, as well as two farmers from the town of Joub Jenine. The Committee is meant to meet regularly with LRA staff (occasionally the LRA general director), at the request of either the farmers or LRA, to discuss issues on the water distributing from Canal 900.

Specifically, the purpose of the Committee is to:

- Collect and prioritize farmers' questions, issues and concerns, and then discuss these with LRA staff along with possible solutions; also commit, in the names of all farmers, to decisions taken collaboratively with LRA; and
- Serve as a communication link between LRA and farmers, notably by assisting the compilation of information from farmers for LRA to handle the start-of-season subscription process.

Two noteworthy achievements from the meetings (described in success stories) were in 2013: the Committee was instrumental in solving a specific conflict between LRA and the Lala Municipality on canal maintenance issues, and led the design of a spring subscription system for wheat irrigation, supplying additional water to farmers and increased revenues to LRA.

6.2.5. MAIN TECHNICAL REPORTS

The following technical reports were produced under Component 3 and posted on DEC:

Farmer satisfaction surveys 2010, 2011, 2012, 2013	March 2011, January 2012, December 2012, December 2013
Mashghara Pipeline Design	April 2010
O&M Plan for Canal 900 (English & Arabic)	April 2011
Demonstration Drip Irrigation Program	November 2011
Land Use and Crop Classification Analysis	February 2012
Modeling of New Gravity Diversions for Canal 900 Network	October 2011

6.2.6. SUCCESS STORIES PROVIDED TO USAID

The impact of LRBMS activities under Component 3 was captured through several success stories:

- November 2010: Soil Analysis Interpretation Training for the Litani River Basin Farmers

- September 2011: Using Drip Irrigation Saves Water & Increases Potato Yield
- August 2012: Coordination Meetings Between Canal 900 Farmers and LRA
- March 2013: Farmers' Committee Facilitates Communications between LRA and Municipality
- May 2013: Transparent Participatory Approach Supported by USAID Leads to More Equitable Water Distribution
- October 2013: LRBMS facilitates LRA-farmers dialogue for win-win outcome

6.3. PROBLEMS AND LESSONS LEARNED

Irrigation management transfer requires first the irrigation network to be solid both structurally and operationally, and second buy-in from both farmers (who must be ready to handle new responsibilities, mostly at delivery level) and LRA staff (who will give away these responsibilities and focus more on conveyance and maintenance). This dual buy-in requires a serious mentality change on both sides, with:

- Farmers ready to select and trust representatives, accept their lead and respect their decisions;
- Farmer representatives ready to negotiate with LRA, take decisions on behalf of their "constituents", and communicate back to them; and
- Finally, LRA staff capable of handling public meetings with farmer representatives, and able to consider farmers as customers.

Worldwide experience shows that the entire WUA approach has to be led by field engineers (who tend to already know and interact with famers) and not by central level experts who make it a theoretical and unsustainable process.

Irrigation is a major water user and polluter in the LRB. Changing practices in terms of water use efficiency and soil management is much needed, and can only happen though awareness raising and technical advice provided to farmers by agricultural extension agents. Unfortunately no extension services are available in the LRB area, except in the northern part:

- LARI (Lebanon Agricultural Research Institute), under the Ministry of Agriculture; and
- AREC (Advancing Research Enabling Communities Center), the experimental farm of AUB.

Both centers focus mostly on research and provide limited extension services to farmers, in the northern part of the LRB. Moreover collaboration between these entities and with LRA remains almost non-existent, despite LRBMS' efforts to that end. As for the LRA Extension Center in Kherbet Hanafar, it remains mostly idle, due to insufficient staff capacity, and lack of accountability/interest from LRA management.

6.4. SUSTAINABILITY AND SUGGESTED FOLLOW-UP

6.4.1. SUSTAINABILITY

The sustainability of LRBMS activities on Canal 900 dams is fairly good since both structural and managerial improvements were designed, planned, and implemented with LRA staff who are under direct farmer pressure to perform and deliver results. The direct communication between LRA and farmers should also continue as both sides saw direct benefits from the interaction.

On the other hand, agricultural extension activities implemented by LRA will have minimal, if any, continuation and replication as the LRA Rural Development Department is plagued with managerial inertia and resistance to change.

6.4.2. FOLLOW-UP THEMES

6.4.2.1. AGRICULTURAL EXTENSION SERVICES

As mentioned above, such services are essential to change practices in terms of water use efficiency and soil management, and additional support is needed to develop these, with the emphasis being on technical advice for farmers (such as soil and water testing), not research.

6.4.2.2. PARTICIPATORY IRRIGATION MANAGEMENT

Transferring to farmers the responsibility (at least at delivery level) of managing irrigation systems is meant to address:

- The lack of accountability, and consequently of competence and dedication, of governmental irrigation managers; and
- The lack of accountability and ignorance of farmers who routinely waste and pollute water.

This approach should be continued in Lebanon, since quantity, quality and governance issues plague the water sector and make it seriously inefficient.

7. COMPONENT 4: RISK MANAGEMENT

7.1. OBJECTIVES AND EXPECTED OUTCOMES

7.1.1. OBJECTIVES AND COUNTERPART

The objectives of this component were to:

- Assess risks associated with dam failure and flooding issues in the Litani River Basin;
- Establish monitoring tools that provide advance indications of potential emergency events; and
- Develop procedures within LRA and in collaboration with stakeholders (such as municipalities) that can mitigate the impacts of such events.

The need for monitoring of the Qaraoun Dam is critical due to its proximity to the Yammouneh fault. Flood events in the Litani basin can affect a rather large area of the Bekaa valley.

The counterpart for dam safety monitoring was the LRA Hydroelectric Exploitation Directorate and the staff posted on Qaraoun Dam. The counterpart for flood management was the LRA Directorate for General Studies.

7.1.2. EXPECTED OUTCOMES

The expected outcomes were:

- Strengthened safety monitoring equipment and processes to improve the capacity to detect and prevent (or at least mitigate) a potential failure of Qaraoun Dam; and
- Better understanding of the extent, magnitude and potential impacts of floods, along with flood damage remedial/mitigation structures and approaches.

7.2. RESULTS

7.2.1. INITIAL ASSESSMENT

LRBMS first conducted an assessment of LRA's risk management capacity as relates to dam safety and floods. The main findings were that:

- Qaraoun dam is performing satisfactorily under normal operations but lacks safety monitoring equipment as wells as a comprehensive dam safety program

- Dam safety monitoring equipment should be tailored to the specifics of the dam and its area through the carrying out of a failure mode analysis;
- Regarding seismic vulnerability, the dam presents positive features (such as proper cleanup of the foundation at the time of construction) and negative factors (strong seismic potential in the area, steepness of the slopes); a quantitative assessment would require a site specific seismic hazard assessment and a deformation analysis of the dam;
- The Feb 2003 flood of the Litani River seems to be the largest in recent memory: the Damascus highway was flooded and not passable by traffic during several days; flood levels and damages were magnified by riverbed infringements, farmer dams, and obstructions such as low bridges;
- A rudimentary flood model has been developed at LRA but is not of much use; and
- No flood management exists as the responsibility is not clearly defined and attributed, while no capacity or equipment exists.

7.2.2. DAM SAFETY ACHIEVEMENTS

A Failure Mode Analysis was prepared to characterize the most likely types of failure for Qaraoun Dam to accordingly define safety monitoring needs (both equipment and procedures). Said equipment was procured and installed and a Dam Safety Monitoring Plan was prepared for LRA staff to implement. LRA staff were sent to a 2-week dam safety monitoring training at the US Bureau of Reclamation. LRBMS conducted two underwater inspections of the dam upstream facing to detect leaks and assisted the successful repair of said leaks. To facilitate future similar inspections, LRBMS purchased a dedicated remotely operated vehicle and trained LRA staff to use it.

Use of Rover for underwater inspections of Qaraoun Dam

Moreover LRBMS conducted a specific seismic sensitivity analysis of Qaraoun Dam (including a computer model of the dam's behavior under earthquake conditions), which confirmed that the rockfill

dam should probably withstand even extreme earthquakes with minimal damage. LRBMS procured and installed overspeed sensors to protect the turbines in case of gallery failure.

LRBMS also conducted a bathymetric survey of the reservoir to assess the amount of sedimentation since construction of the dam (which so far remains modest). Finally LRBMS assessed the potential impact of a hypothetical (but highly unlikely) failure of Qaraoun Dam and mapped the potentially impacted areas, using satellite pictures and a Digital Terrain Model. An Emergency Management Plan was prepared to guide Lebanese Authorities in such a case.

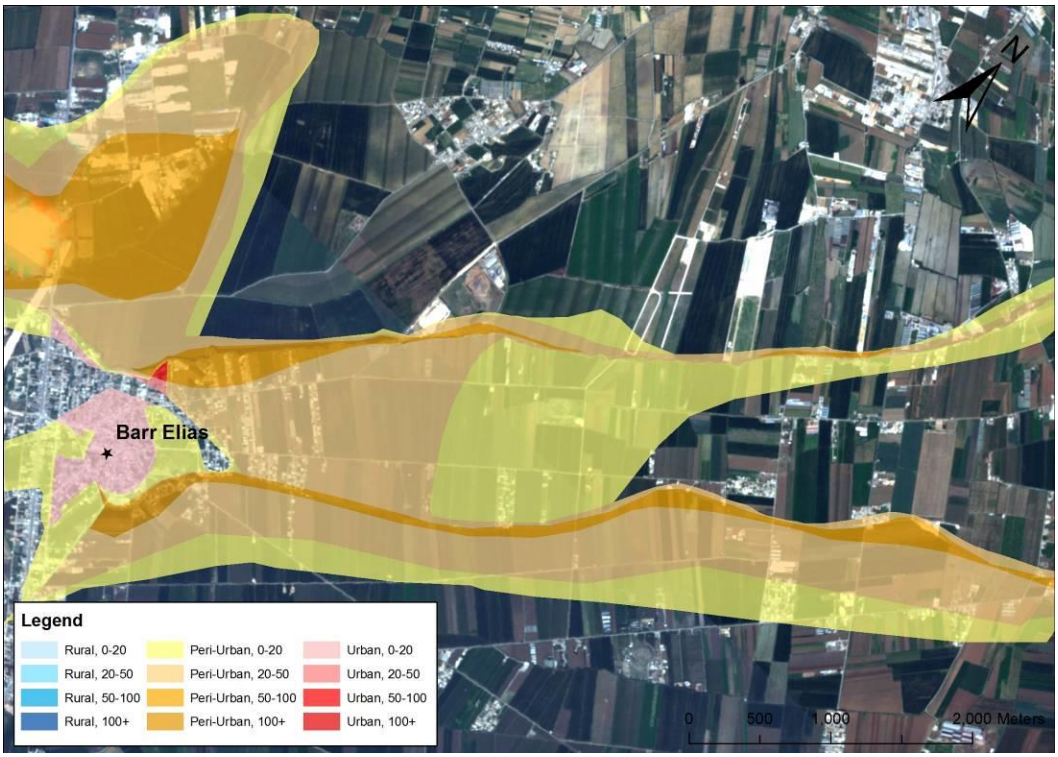
Repair of joint leaks on Qaraoun Dam

7.2.3. FLOOD MANAGEMENT ACHIEVEMENTS

LRBMS conducted a flood field survey on the February 2003 flood to identify its extent and magnitude in terms of impacted areas, flood levels and damage. A computer river flow model was then built (under HEC-RAS) and calibrated on the collected information, using both topographical data and satellite imagery. This model was used to predict the extent and magnitude of different levels of floods and to test various flood management approaches and works.

A flood management plan was accordingly prepared to assist LRA and Municipalities to plan for future events, emphasizing that:

- Flooding is a common occurrence in the LRB but most waterlogging is due to heavy winter rains, clayey soils, and lack of urban and rural drainage;
- Floods from the Litani River do occur as natural events, but their impacts are increasing with the development of human activities (farming and urbanization);
- Unregulated human activities such as dumping of solid waste, construction of small diversion dams by farmers, along with undersized crossing structures (culverts and bridges) and the lack of riverbed maintenance amplify the impact of floods; and
- Structural solutions (such as embankments and dams), tend to be both expensive and dangerous, priority should thus be given to natural solutions (such as flood expansion areas) and nonstructural approaches (such as smart urban planning).



Mapping of flood-prone areas with submersion depths (cm)

7.2.4. CAPACITY-BUILDING ACTIVITIES

The main training courses and presentations provided to LRA were the following:

Dam Safety	August - September 2010
Dam Safety	April 2011
Dam Monitoring Equipment	September 2011
Flood Model	October 2011
Dam Monitoring Equipment	December 2011
O&M of Overspeed Sensors	December 2011
Dam Break Modeling	December 2011
ROV Training	April 2012
Seismic Analysis	April 2012

7.2.5. MAIN TECHNICAL REPORTS

Several technical reports were produced under Component 4 and posted on DEC.

Regarding dam safety:

April 2010	Dam Instrumentation Evaluation And Recommendations (PFMA)
April 2010	Inspection of Qaraoun Dam joints
March 2011	Dam Safety Monitoring Plan
January 2012	Dam Break Modeling For Qaraoun Dam
February 2012	Seismic Deformation Analysis of Qaraoun Dam
April 2012	Rover Training and Dam Inspection
September 2012	Qaraoun Dam Emergency Plan

Regarding flood management:

August 2010	Flood Field Survey Report
May 2012	Flood Management Report
May 2012	Flood Management Report - Extract (English & Arabic)

7.2.6. SUCCESS STORIES PROVIDED TO USAID

The impact of LRBMS activities under Component 4 was notably captured through success stories:

- April 2010: Improved dam safety for Qaraoun Dam
- November 2010: Dam Safety Seminar and Study Tour for Litani River Authority Staff
- December 2010: Joints Repair for Qaraoun Dam
- December 2011: New Overspeed Detection System for LRA
- April 2012: Seismic Analysis of Qaraoun Dam
- May 2012: USAID Improves the Capacity of Litani River Authority to Maintain Qaraoun Dam
- July 2013: USAID Provides Equipment and Capacity Building for Better Monitoring of the Qaraoun Dam

7.3. PROBLEMS AND LESSONS LEARNED

Two specific issues were faced when addressing flood issues:

- Disregard for field investigations and over-reliance on computer modeling without a full understanding of the need for calibration; and
- Disregard for non-structural solutions to mitigate flood damage.

Hopefully LRBMS' approach and activities built capacity on both accounts.

7.4. SUSTAINABILITY AND SUGGESTED FOLLOW-UP

7.4.1. SUSTAINABILITY

The sustainability of LRBMS activities on dam safety monitoring is good since Qaraoun Dam is the "raison d'être" of LRA and its single source of revenues (through electricity sale to EDL).

On the other hand, LRA was not empowered with the responsibility of maintaining the Litani River or managing flood issues (as planned by the MEW) so the flood management plan will probably not be implemented, even if copies where provided to concerned Municipalities. Moreover flood issues (like drought issues) tend to be ignored by both Lebanese decision-makers and people until these unfortunate events actually occur. Regarding the flood computer model, it could be easily re-used or improved by future projects.

7.4.2. FOLLOW-UP THEMES

Risk management should continue to be supported as a much cheaper approach than crisis management. Unfortunately, pro-active planning and management is rare and often ignored in Lebanon.

As an example, the flood management plan prepared by LRBMS received modest attention and will not probably be utilized until floods do actually occur. It is interesting to note in this Spring 2014, that there is much talk about drought management, due to the very dry winter, while this topic was never mentioned before, and will likely be forgotten once the drought is over.

8. PERFORMANCE MONITORING

8.1. ADMINISTRATIVE DELIVERABLES

The following deliverables were prepared and submitted to USAID, as per contract:

Title	Submitted
2010	
Start-Up Plan	October 2009
Subcontractor Management Plan	October 2009
Initial Assessment Report (IAR)	December 2009
Environmental Assessment (EA) Report	Not requested, covered by IIE 216 prepared by USAID Lebanon)
2010	
First Quarterly Report	January 2010
First Annual Work Plan	January 2010
First Annual Training Plan	March 2010
Life of Project (LOP) Procurement Plan	March 2010
Performance Monitoring Plan (PMP)	March 2010
Second Quarterly Report	April 2010
Third Quarterly Report	July 2010
Second Annual Work Plan and Training Plan	September 2010
Fourth Quarterly Report	October 2010
2011	
Fifth Quarterly Report	Jan 2011
Sixth Quarterly Report	April 2011
Seventh Quarterly Report	July 2011
Eighth Quarterly Report	October 2011
Third Annual Work Plan and Training Plan	October 2011
2012	
Ninth Quarterly Report	January 2012
Tenth Quarterly Report	April 2012
Revised PMP	May 2012
Eleventh Quarterly Report	July 2012
Fourth Annual Work Plan and Training Plan	September 2012
Twelfth Quarterly Report	October 2012
2013	
Thirteenth Quarterly Report	January 2013
Fourteenth Quarterly Report	April 2013
Fifteenth Quarterly Report	July 2013
Sixteenth Quarterly Report	October 2013
Fifth Annual Work Plan and Training Plan	October 2013
2014	
Seventeenth Quarterly Report	Jan 2014
Demobilization Plan	Jan 2014
Disposal Report	March 2014
Project Completion Report	April 2014

8.2. M&E SUMMARY

The table page 57 updates all PMP indicators as of end of project. All numbers (target and actual) are for a specific year and thus not cumulative. Specific comments are also provided hereafter for each indicator:

AO: Improved Water Services for all in the Litani River Basin

- Indicator #1 - Percent customer satisfaction with water services in Canal 900 area: an annual survey was carried out four times, starting in 2010 (Year 1); the customer satisfaction index is stable at a mediocre 45%, with 2011 (Year 2) as an exception which can be explained by the abundant and late (until May) rains that decreased the need for farmers to access reliable water from the canal; the impact from the project activities (construction of gravity diversions to increase supply, facilitation of LRA-famers meetings to improve dialogue) will not be felt until summer 2014; but the customer satisfaction in 2014 may actually decrease due to the upcoming drought and the real possibility that Canal 900 will not be able to operate this summer.
- Indicator #2 - Number of RBMP endorsed: RBMP volume 1 (assessment) and volume 2 (action plan) were endorsed by Municipalities.

	First Draft	**Final Draft**	**Endorsed**
Volume 1	November 2011	February 2012	By Municipalities in May 2012
Volume 2	November 2012	April 2013	By Municipalities in July 2013

IR 1 More efficient water management in the Litani RB

- Indicator #3 - Percent Canal 900 actual served area: stable around 35%, due to the delay in operating the gravity diversions, which will only start in 2014 (if Canal 900 does operate as the upcoming drought may prevent it).
- Indicator #3b – LRA income from Canal 900 ($1000): since served area did not change, the increase is due to a 20% raise of the subscription fee applied by LRA in the 2013 season.
- Indicator #4 - Number of hectares formerly irrigated from sewage & now irrigated from freshwater: due to completion and operation of Machghara pipeline.

IR 1.1 Improved capacity of LRA

- Indicator #5 - Number of staff from LRA (and other water entities) trained by LRBMS; targets were not reached in Years 4 and 5 as LRA did not buy-in to LRBMS's offer to train the 27 newly recruited staff.
- Indicator #5b - Number of trainee-days (staff from LRA and other water entities trained by LRBMS): this second indictor is included to better monitor actual training days; the same staff may be trained on several different topics, and this is not captured by the previous indicator;

Moreover job assistance, which cannot be accurately counted, has been extensive throughout the life of the project (for example: over 50 days of debugging on the upgraded financial system, over 80 days of assistance on water monitoring, etc.).

- Indicator #6 - Number of LRBMS-prepared management systems & plans used by LRA:

Title	First Draft	Final Draft	Endorsement
Dam Safety Monitoring Plan	February 2011	April 2011	Yes (Year 4)
Water Monitoring Plan	May 2011	January 2012	Under review
O&M Plan for Canal 900	April 2011	April 2011	Yes (Year 4)
Water Quality Data Base	March 2012	March 2012	Yes (Year 4)
Flood Management Plan	April 2012	May 2012	Yes (Year 4)
Emergency Management Plan	December 2012	January 2013	Yes (Year 5)

Water Monitoring plan was never formally endorsed due to reluctance to change at the LRA Water Resources Department.

IR 1.2 Increased participation of Litani water users in water management

- Indicator #7 - Number of water users trained by LRBMS: mostly extension activities to farmers, also public meetings with residents and water users.
- Indicator #7b - Number of trainee-days (water users trained by LRBMS): this second indictor is included to better monitor actual training days. The same water user may be trained on several different topics, and this is not captured by the previous indicator.
- Indicator #8 - Number of public meetings held by LRA with water users

IR 2 Improved Water Infrastructure

- Indicator #9 - Number of Dam safety equipment installed by LRBMS: all the equipment has been installed and connected.
- Indicator #10 - Kms of additional irrigation networks built by LRBMS: due to construction and operation of Mashghara pipeline (three kilometers) and the two Canal 900 gravity diversions (two kilometers).
- Indicator #11 - Operating automated monitoring stations in Litani River Basin: five surface gauging stations and fourteen observation wells completed, one groundwater well was dropped.
- Indicator #12 – Number of wetland hectares constructed by LRBMS: construction and operation of Litani River treatment wetland in Joub Jenine.

IR 3 Enhanced Water Governance

- Indicator #13 - Number of LRBMS-prepared reports proposing legal, policy, institutional measures:

Title	First Draft	Final Draft	Endorsement
The Role of LRA: Present and Future	April 2010	July 2010	Yes
LRA Vision	August 2010	November 2010	Yes
Restructuring the Litani River Authority	April 2012	August 2012	Yes
Action Plan for Water Awareness & Enforcement	January 2014	March 2014	Pending

- Indicator #14 - Revised LRA mandate: pending buy-in from MoEW.

Title	First Draft	Final Draft	Endorsement
LRA Mandate	September 2012	October 2012	Yes by LRA

Basin Management Effectiveness

- Indicator #15 - Number of LRA monthly water monitoring reports: these continue to be prepared by LRA.

Basin Management Efficiency

- Indicator #16 - Percent of Canal 900 system efficiency: this indicator is based on the total volume provided by the system, divided by the volume needed (according to the served area and the service period); this indicator should increase to show better water use; over the past four years, this indicator has been steadily decreasing, mostly due to an increase in the volume pumped (about 8 Mm^3 in 2010 and 2011, 9 Mm3 in 2012 and 2013), which is due to increasing non-paying, non-metered, direct withdrawals along the Litani River (including the Mashghara diversion, for about 0.3 Mm^3/year, where LRA chose not to have farmers pay).

Basin Management Sustainability

- Indicator #17 – Water quality index: dropped as LRBMS would not have a measurable impact. It would however be an excellent indicator for LRA.

M&E reporting table

	LRBMS Project Indicators	Source	Type	Baseline	Year 1		Year 2		Year 3		Year 4		Year 5		Source of data	Total life of project	
					Target	Actual	Target	Actual	Target	Actual	Target	Actual	Target	Actual		Target	Actual
	AO: Improved Water Services for all in the Litani River Basin																
1	% customer satisfaction with water services in Canal 900 area	USAID	outcome	46%	baseline		50%	69%	60%	43%	65%	45%	-	-	Survey	N/A	N/A
2	# RBMP endorsed by Municipalities	custom	outcome	0	0	0	1	0	1	1	1	1	-	-	LRBMS	2	2
	IR 1 More efficient water management in the Litani RB																
3	% Canal 900 actual served area	custom	outcome	33%	baseline		40%	34%	50%	35%	60%	35%	-	-	LRA	N/A	N/A
3b	LRA Income from Canal 900 ($1000)	custom	outcome	313			baseline		400	319	500	377	-	-	LRA	N/A	N/A
4	# hectares formerly irrigated from sewage & now irrigated from freshwater	custom	outcome	0	0	0	100	100	-	-	-	-	-	-	LRBMS	100	100
	IR 1.1 Improved capacity of LRA																
5	# of staff from LRA (and other water entities) trained by LRBMS (and # women)	USAID	output	0	30	29(7)	50	44(10)	50	70(24)	70	23(12)	20	12(5)	LRBMS	100	98(28)
	# of trainee / days (LRA and other water entities staff trained by LRBMS)				100	226	150	347.75	150	105	100	90	20	6		500	768.75
6	# management systems & plans used by LRA as a result of LRBMS	USAID	output	0	0	0	3	0	3	1	6	4	2	1	LRBMS	6	5
	IR 1.2 Increased participation of Litani water users in water management																
7	# water users trained by LRBMS (and # women)	USAID	output	0	20	0	50	37 (2)	50	73(12)	100	35(2)	-	-	LRBMS	100	112(13)
	# of trainee / days (water users trained by LRBMS)						50	47	50	96	100	39	-	-		200	182
8	# public meetings held by LRA with water users	USAID	outcome	0	1	1	3	5	3	10	3	8	4	2	LRA	10	26
	IR 2 Improved Water Infrastructure																
9	# Dam safety equipment installed by LRBMS	custom	output	0	0	0	8	8	2	1	1	1	-	-	LRBMS	10	10
10	kms of additional irrigation networks built by LRBMS	custom	output	0	0	0	3	3	2	2	-	-	-	-	LRBMS	5	5
11	# Operating automated monitoring stations in Litani River Basin	custom	outcome	2	2	2	5	5	8	8	7	6	-	-	LRA	22	21
12	Wetland constructed by LRBMS (# of hectares)	custom	output	0					3	0	3	3	-	-	LRBMS	3	3
	IR 3 Enhanced Water Governance																
13	# LRBMS-prepared reports proposing legal, policy, institutional measures	USAID	output	0	1	2	0	0	1	1	1	1	-	-	LRBMS	4	4
14	# Revised LRA mandate	custom	outcome	0	0	0	1	0	1	0	1	1	-	-	LRBMS	1	1
	Basin Management Effectiveness																
15	# Monthly water monitoring report	custom	outcome	0					6	11	12	12	6	3	LRA	24	26
	Basin Management Efficiency																
16	% Canal 900 system efficiency	custom	outcome	69%	N/A	75%	N/A	69%	75%	67%	80%	63%	-	-	LRA	N/A	N/A
	Basin Management Sustainability																
	N/A																

Notes:
All numbers are for the year only and not cumulative.

9. STAFFING OVERVIEW

9.1. STAFFING

The LRBMS technical assistance team was led by Eric Viala, Chief of Party, who has been permanently based in Lebanon since November 2009. He was assisted by three long-term administrative staff:

Name	Function
Randa Issa	Financial/office manager
Diana Shannan	Communications/M&E specialist
Farah Rowasatti, then Malak Hajjar, then Abir Hajjar	Administrative assistant/Training Coordinator

Through DAHNT, two long-term staff were also involved:

Name	Specialty	Component
Walid Abi Akar, then Hussam Hawwa	Water Management Specialist	1 – Cap Building
Gerges Rizk, then Dr Fadi Karam	Agricultural Engineer	3 – Irrig Managt

The following expatriate STTA specialists contributed to LRBMS through short-term assignments:

Name	Specialty	Component	Timing
Carl Brush	Legal/Institutional	1 - IRBM Capacity Building	Nov 2009
Tom Sheng	Database/GIS	2 – Water Monitoring	Nov 2009
Pascal Boderie	Water Quality	2 – Water Monitoring	Nov 2009
Robert Hill	Irrigation	3 - Irrigation	Nov 2009
John Smart	Dam Safety	4a - Dam	Nov 2009
Geert Prinsen	Floods	4b - Floods	Dec 2009
2010			
Andy Tczap	Dam Safety	4a – Dam Safety	Jan 2010
Lori Severens	Communication	All	Feb 2010
Tom Sheng	Database/GIS	2 – Water Monitoring	Feb 2010
Mark Svendsen	M&E	All (PMP)	Feb 2010
Firras Traish	Procurement	All (Procurement)	Mar 2010
Gary Merkley	Irrigation O&M	3 – Irrigation Management	Mar 2010
Andy Tczap	Project Management & Dam Safety	All	June 2010
Mark Svendsen	M&E	1 - IRBM Capacity Building	May 2010
Grant Cardon	Soil Management	3 – Irrigation Management	May 2010
Robert Hill	Irrigation Management	3 – Irrigation Management	June 2010
Mark Svendsen	M&E	1 - IRBM Capacity Building	Aug 2010

Vince Uhl	Hydrogeology	2 - Water Monit.	Aug 2010
Gary Merkley	Irrigation Management	3 - Irrigation Management	Aug 2010
Tom Sheng	GIS and databases	2 - Water Monit.	Sep 2010
Joan Ablett	Communications	All	Dec 2010
Andy Tczap	Project Management	All	Dec 2010
2011			
Bob Hill	Irrigation	3 – Irrigation Management	Jan 2011
Gary Merkley	Irrigation networks	3 – Irrigation Management	Apr 2011
Tom Sheng	Remote Sensing	2-Water Monitoring	May 2011
Vince Uhl	Groundwater	2-Water Monitoring	May 2011
Matthew Fry	HYDATA Water Database	2-Water Monitoring	May 2011
Grant Cardon	Soil Management	3 – Irrigation Management	May 2011
Meghan Hartman	Water Management	1 - IRBM Capacity Building	July 2011
Jim Tarrant	Project Director	All	Aug 2011
Mark Svendsen	Water Institutions	1 - IRBM Capacity Building	Oct 2011
Phil Brown	Water Quality	2 - Water Monitoring	Nov 2011
Xu Chunrong	Electro-Mechanical	4a - Dam Safety	Dec 2011
Daene Mckinney	Flood Modeling	4a - Dam Safety	Dec 2011
2012			
James Tarrant	Project Director	All	Jan 2012
Vincent Uhl	Groundwater	2 - Water Monitoring	Jan 2012
Bill Jaeger	Economics	1 - IRBM Capacity Building	Jan 2012
Paul Frank	Wetland	1 - IRBM Capacity Building	Jan 2012
Meghan Hartman	Water Quality	2 - Water Monitoring	Mar 2012
Alex Kaplan	Rover Training	4- Dam monitoring	Apr 2012
Faiz Makdessi	Seismic Analysis	4 - Dam monitoring	Apr 2012
Paul Frank	Wetland	1 - IRBM Capacity Building	May 2012
Mark Svendsen	Water Institutions	1 - IRBM Capacity Building	May 2012
Russ Misheloff	Project Management	All	Aug 2012
Meghan Hartman	Water Management	1 - IRBM Capacity Building	Nov 2012
Andy Tczap	Project Management	All	Dec 2012
2013			
Firras Traish	Project Close-out	All	Mar 2013
Andy Tczap	Project management	All	Dec 2013
2014			
Dieynaba Diallo-Bah	USAID Compliance	All	Mar 2014
Jonathan Schwarz	Project Close-out	All	April 2014

They were assisted by STTA consultants, most of them being provided by DAHNT:

Name	Specialty	Component

Elias Haddad	Project Manager	All
Bassam Jaber	Water Institutional Specialist	1 – Capacity Building towards IRBM
Said Bitar	Institutional Specialist	
Mona El-Rez	Water Quality Specialist	
Joelle Puig	Water Institutional Specialist	
Antoine Abou Samra	Water Quality Engineer	2 – Water Monitoring
Khalid Mansour	Hydrogeologist	
Wassim Katerji	GIS Specialist	
Dr Antoine Hreiche	Water Monitoring Specialist	
Dr Mark Saadeh	Water Quality Specialist	
Rida Joma	Water Data Specialist	
Marie-Helene Nassif	Irrigation Management Specialist	3 - Irrigation Management
Joseph Serhal	Agricultural Economist	
Rabeh Darwiche	Civil Engineer	
Hussein el Hajj Hassan	Worksite Engineer	
Antoine Abou Samra	Design Engineer and Contract Specialist	
Wael Sabra	Dam Instrumentation Engineer	4a – Dam Safety Monitoring
Robert Bou Nahed	Hydraulic Modeling Engineer	4b – Flood Management
Mohammad Dalleh	Field Engineer	

9.2. MAIN SUBCONTRACTORS

Several international and Lebanese firms were subcontracted by IRG for the implementation of LRBMS activities, the main ones being:

- Dar Al Handasah Nazeh Taleb (DAHNT), a Lebanese engineering and consulting firm that was involved in all components, providing technical experts notably on:
    - Design and work supervision on construction activities (Mashghara pipeline, Canal 900 diversions, Litani River treatment wetland);
    - Dam safety monitoring, flood management;
- Utah State University (USU) supplied three irrigation experts to assist with the initial analysis of irrigation conditions and practices in the LRB and specifically of the Canal 900 system;
- American University of Beirut (AUB) carried out three water quality surveys in the LRB;
- Computer Assisted Development Inc. (CADI), a US small business, provided expertise on water monitoring, water database management and GIS;
- UHL & Associates, Inc., a US small business, assisted with groundwater/hydrogeology expertise;

- Allied Business Advisors (ABA), a Lebanese firm, advised on the design, and supervised the deployment of an upgraded accounting/financial system for LRA;
- Al Bonyan, a Lebanese contractor, implemented three construction activities (Mashghara pipeline, Canal 900 diversions, Litani River treatment wetland);
- NewFields, a US engineering company, delivered a feasibility study and a design report for the Litani River treatment wetland;
- Earth Link & Advanced Resources Development (ELARD), a Lebanese consulting firm, assisted with the deployment of gauging stations and groundwater observation wells, and developed the LRB groundwater monitoring model;
- AMEC Geomatrix, a US consulting firm, carried out the seismic analysis of Qaraoun Dam;
- Aquatic Sciences and Seatrepid, both US firms, conducted underwater inspections of Qaraoun dam as well as training on the use of the rover
- Environmental Law Institute (ELI), a US consulting group, contributed the initial assessment of the water governance situation in Lebanon; and
- Management Of Resources and Environmental Solutions (MORES), a Lebanese consulting firm, provided technical assistance on the design of awareness documents.

10.TRAINING AND PROCUREMENT ACTIVITIES

10.1. TRAINING ACTIVITIES

Formal and informal training and capacity building activities were an integral part of LRBMS. These were listed under each of the four components. On-the-job assistance was also constant to reinforce training and much facilitated by LRBMS being hosted within LRA office.

10.2. PROCUREMENT

LRBMS has been procuring two types of non-expendable property, as per the approved budget and procurement plan:

- Equipment, spare parts and other non-expandable items purchased to improve water management in the Litani River Basin, which was the overarching goal of LRBMS; and
- Equipment necessary for the LRBMS office and for the LRBMS staff to operate.

A procurement plan was submitted and approved by USAID in Year 1 of the project and listed most of the items procured under LRBMS. Some additional, unforeseen procurement was carried out in Years 2 to 5 to adjust to LRA needs and changes in the project tasks.

The list of all procured items was presented to USAID in a disposal plan which was also approved by USAID in March 2014:

- All non-expendable items purchased by LRBMS to support the technical activities and capacity-building towards better water management in the LRB were transferred to the counterpart agency, the LRA; the transfer occurred upon reception of the items, or after proper training and capacity-building had been provided to LRA staff;
- Non-expendable property purchased during the life of the project for IRG to perform its activities under LRBMS remained in the custody of IRG until the end of the project, and was then transferred to LRA; and
- One vehicle purchased under LRBMS for professional use was also transferred at the end of the project, from IRG Lebanon to LRA.

11.CROSS-SECTORAL ACTIVITIES

11.1. GENDER EQUITY

LRBMS actively promoted gender equity throughout all project activities, even when women are unfortunately a tiny minority (among engineers, managers, mayors, farmers, etc.). Examples are:

- One lady engineer was among the six LRA employees sent for training to the US on dam safety monitoring; and
- One woman farmer was among the pilot farmers that LRBMS collaborated with on the use of drip irrigation equipment.

M&E training figures provide gender disaggregated results. During its awareness activities, LRBMS specifically organized meetings with women in several LRB Municipalities, and advocated for the involvement of women leaders in the Municipal water committees that were organized.

LRBMS' permanent staff included three women out of a total of six employees.

11.2. ADAPTATION TO CLIMATE VARIABILITY

Climate change is proven fact which will impact weather patterns and thus the availability and use of water resources. LRBMS activities were essential tools to deal with climate variability:

- Better monitoring of water quantity and quality allows to:
    - Know the availability and uses of water resources, at present and in the future;
    - Understand current and future shortages and their causes;
    - Anticipate variations (in both availabilities and uses); and
    - Test and define adaptation measures;
- Improved irrigation management allows to:
    - Build collaboration between managers and farmers as well as among farmers, thus mitigating the impact of conflicts in times of water stress;
    - Increase water use efficiency ("do more with less");
- Enhanced risk management allows to be prepared for extreme events, anticipate their impacts, and mitigate the damage they may cause;

- Finally the adoption of IWRM/IRBM principles (notably participation and sustainability) allows for more responsible water use behaviors and practices, which are more resilient to weather variability.

Since climate change adaptation is embedded in the river basin planning approach promoted by LRBMS, no specific activity was developed beyond consideration within the next of strategic planning..

11.3. ENVIRONMENTAL MANAGEMENT

This Environmental Compliance Report covers the measures and processes adopted under LRBMS to identify, plan for and mitigate environmental impacts of project activities.

11.3.1. COMPLIANCE WITH USAID ENVIRONMENTAL REGULATIONS

The Litani River Basin Management Support (LRBMS) project's design was reviewed in an Initial Environmental Examination (IEE), as required by 22 CFR 216, USAID's environmental compliance procedures. The review, prepared in September 2009 and updated in August 2011, recommended two determinations:

a) Categorical exclusion for those activities that typically do not have any significant environmental impacts, and

b) Negative determination with conditions for those activities in the project that may give rise to environmental impacts unless mitigation measures are put in place that will change either the design and/or location to prevent such impacts and where guidance to contractors regarding best practices for the construction and/or operations will, if implemented prevent or mitigate other environmental impacts.

Specific environmental screening and Environmental Mitigation and Monitoring Plans were prepared, submitted to USAID, and implemented for the main activities:

- Construction of Machghara Pipeline
- Installation of Water Monitoring Stations
- Construction of Canal 900 Diversions
- Construction of Litani River Constructed Treatment Wetland

11.3.2. COMPLIANCE WITH LEBANESE ENVIRONMENTAL REGULATIONS

Environmental legislation is recent in Lebanon. Ministry of Environment was established in 1993, and its mandate clarified in 2005. The main environmental governance Law (444/2002) was promulgated in 2002 and specifically includes an Environmental Impact Assessment (EIA) process to control and mitigate environmental degradation. Actual implementation of that Law required however many

application decrees, most of which are still pending. The EIA decree was finally promulgated in June 2012 (8633/2012) but not presented or disseminated to other governmental agencies or the public at large. Its interpretation, implementation, and enforcement are still unfolding processes.

None of the small-scale construction activities carried out or planned by LRBMS before promulgation of the decree would have required EIAs because of their type or their small size. The construction of the Litani River Wetland may require an EIA based on decree 8633 because of its type (wetland) and location (next to the Litani River). LRA as governmental agency authorized LRBMS to proceed and conducted in parallel an intensive coordination with the Ministry of Environment to request additional guidance which is still pending as of closure of LRBMS.

11.4. COORDINATION WITH OTHER PROJECTS/DONORS

LRBMS coordinated closely with other donor-funded water programs such as:

- USAID-funded Small Villages Wastewater Treatment Systems (SVWTS), Lebanon Water and Wastewater Sector Support (LWWSS), and Water Infrastructure Support and Enhancement (WISE);
- UNDP-funded Lebanon Groundwater Assessment and Database, on groundwater monitoring;
- EU-funded Sustainable Water Integrated Management (SWIM), on the economic impact of pollution in the LRB; etc.

LRBMS also attended the regular water donor coordination meetings held at the MEW or at the European Delegation.

12.MAIN REFERENCES

Overall condition of the Litani River Basin:

- LRBMS Walk-Through, 2011
- Description of the selected non-EU River Basin Litani, SPI-Water, EU/WFD, 2007
- LRBMS River Basin Management Plan, Volume 1 - Assessment, 2012

Water Management in Lebanon:

- Lebanon - Country Water Sector Assistance Strategy, World Bank, 2012
- Lebanon – Water Sector: Public Expenditure Review, World Bank, 2010

Water Management Plans for Lebanon:

- Work Plan- Ministry of Hydraulic and Electric Resources, General Directorate of Hydraulic and Electric Equipment, 2000
- National Water Sector Strategy, Ministry of Energy and Water, 2012
- Blue Gold Plan, 2013

Water Management Plans for the Litani River Basin:

- Development Plan for the Litani River Basin, Lebanon, US Bureau of Reclamation, 1954
- LRBMS River Basin Management Plan, Volume 2 - Action Plan, 2013

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